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# WORK BOOK IN SURGERY

COMPRISING

THE PRINCIPLES OF GENERAL SURGERY AND SURGICAL PROCEDURE.

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1902.
PRIVATELY PRINTED.
ITHACA, N. Y,

4841

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PRESS OF
JOURNAL JOB DEPARTMENT,
ITHACA, N. Y.

*Inspired by the wants and dedicated to the needs of the Cornell Medical Student.*

The writer wishes to acknowledge the kind offices of Dr. J. Collins Warren, of Harvard University, for help in the preparation of the chapters on tumors ; and of Dr. John S. Shearer, of Cornell University, in the preparation of the chapter on X-rays.

September, 1902,
Ithaca, N. Y.

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BOSTON MEDICAL

# INFLAMMATION, HYPEREMIA, EXUDATES, TYPES OF INFLAMMATION, REPAIR OR REGENERATION, REACTION=FEVER.

**Inflammation** is a condition of hyperemia and cell proliferation, of a tissue or organ, characterized by heat pain, changed color, swelling and altered function.

**Lesion.**—If we examine microscopically a bit of mesentery or tongue of a frog or the tip of a rabbit's ear, that has been pinched or irritated by some chemical such as stronger acetic acid, we see the following changes in the blood vessels and blood. First there takes place a dilatation of the vessels. Then in a half hour's time there is a marked increase in the rapidity of the blood flow. Subsequently there is an equally marked slowing of the blood current and an accumulation in the veins and capillaries. Finally there may be stasis. Meanwhile changes have taken place in the elements of the blood current. Instead of the normal centralization of the cell elements within the serum, the white blood cells or leucocytes have entered the peripheral serum-current and roll along and occasionally catch at the wall.

And as the condition of stasis approaches, these cells stop and push their way outside the vessel through the widened and thinned cement substance of the dilated vessel. This is known as the migration of the white blood cells and takes place in the veins and capillaries. These cells are small and mononuclear or larger polynuclear. The polynuclear comprise about 70 percent of the leucocytes in an inflammation field. Next there is a diapedesis of red blood cells and blood plates which takes place only in the capillaries. At the same time there occurs an transudate of serum

from the blood. These elements in varying proportion constitute the exudate of a simple inflammation. The irritation instead of being physical or chemical may be due to bacteria or their metabolic products, the necleins or toxins.

Secondarily, in a simple inflammation, proliferation of the connective tissue cells occurs. There is a reversion to an embryonic type ; fission or karyokenesis follows, and results in an increase of small round cells outlying the blood vessels in the inflamed area.

These leucocytes and these proliferated connective tissue cells flow out into the surrounding lymph spaces and into the relaxed connection tissue outlying the blood vessels of the inflamed area and tend to wall off the area of inflammation ; or they become wander cells and going out into new lymph spaces and invading new tissue tend to spread the area of inflammation.

If the inflammation be at all severe,—much exudate formed and much cell proliferation—the endothelial cells of the blood vessels begin either to bud or to proliferate in filaments through this mass of inflammatory exudate. The buds undergo fatty degeneration of their central protoplasm and become hollow ; the filaments become double-walled and patent. This organization of new blood vessels takes place secondarily, but is always present if the amount of inflammation is at all considerable.

**Causes.**—Due to the special mode of irritation—whatever it is—there are molecular changes in the vessel walls by which the endothelial cells are rendered more patent. Vasomotor (dilator) changes in the vessel allow the weakening of the cement substance the diapedesis and migration of blood cell elements. Chemotaxis causes the transudate of serum. Reaction accounts for the proliferation changes in the outlying connective tissue cells, and their separation from the vessel walls.

Broadly the causes are mechanical or traumatic, thermal, chemical or bacterial.

**Symptoms.**—The dilation and congestion of capillaries and the consequent increase of blood supply to an inflamed part causes a diffused blush or redness. With varying conditions a pallor may mark the seat of inflammation especially if the pressure of the exudate cuts off all or most of the blood supply to the part. So, a change in color is symptomatic of inflammation. The pressure of the exudate upon nerve terminals causes pain, due to anemia of the nerve. The increase in blood supply to the part with increased radiation from the part gives to the hand placed upon the part a sensation of heat. The exudate and increased circulation causes swelling. Due partly to pain, in part to swelling, the inflamed area is kept quiet and there follows loss of function.

**Diagnosis** is made according to the variation in exudate. A small amount of exudate of simple character would constitute a mild inflammation. Much exudate with accompanying severe symptoms would constitute a severe type of inflammation. The location in the vicinity of a rich nerve or lymphatic supply, especially if set within firm fascia, would cause the inflammation to be painful if not severe. Nearness to the surface, rapidity of development and severe type of irritation, would increase the redness in a part. An inflammation that accomplishes repair in one to two weeks is known as acute ; in two to six weeks as sub-acute ; in four weeks to a year or more as chronic. According to location an inflammation is superficial, or deep ; is parenchymatous if it involves cells of an organ ; or interstititial if it follows the connective tissue stroma between cell areas. An inflammation may extend beyond the point primarily involved by infiltration of the connective tissue spaces ; or by

metabolism through lymph vessels and spaces and through blood vessels, especially veins.

Diagnosis of inflammation, aside from the use of the cardinal symptoms of heat, pain, swelling, altered color and function, is accomplished by use of certain mechanical aids. By inspection, contour color size and asymetry are determined. Palpitation gives a determination of pain swelling and general physical values, such as fluctuation in a part. By fluctuation is determined the presence of serum or pus. By percussion are determined certain tissue thickenings over cavity spaces ; the trained ear, auscultation, also aids in determining these physical values. Certain surgical instruments such as the hypodermic syringe, thermometer, stethoscope and probes aid materially in guaging conditions and determining true estimates.

**Prognosis** in an inflammation depends primarily upon the character and extent of the process. If the leucocytes number only forty to a hundred thousand per cubic millimeter in the transudate and there result four hundred to sixteen hundred thousand pus cells within two days and the resulting pus is not liberated from the tissues, the outcome is bad and will result in large death of tissue ; or in metabolic inflammation at some distant point ; or in absorption of the poisonous toxins ; or in death. Such a pus development, uncared for, would cause fever and tissue waste. It might cause phlegmon or general involvement of an extremity, and death. Due to pressure upon the veins and a stasis in the veins, there might result gangrene of a part or an extremity, and death. Or if the pus collection be evacuated, healing takes place by granulation and scar tissue formation with accompanying alleviation of all symptoms and a return to practical normal. Or, repair may be had by degeneration of the elements of the exudate, absorption of the products, and a return to normal with regeneration

of cells of the tissue or organ. Or a foreign body may remain in the tissue and may encapsulate and remain innocuous, or it may be a continued menace and a constantly recurring cause of inflammation.

**Treatment** depends upon conditions. By prophylaxis is meant methods of protection against disease conditions. Having acquired a disease or inflammation prophylactic measures avail nothing. We now make use of aseptic or antiseptic methods as the case may demand. Or by antiphlogystics, such as elevation and a position of relaxation and applications of evaporating solutions or of ice, the patient is made more comfortable. Each special inflammatory condition will severally need its special treatment. Aside from the purely local treatment we employ methods of constitutional treatment to clear up general bodily conditions such as headache, fever, vomiting, sleeplessness and constipation. These also will vary somewhat with conditions.

**Hyperemia,** or congestion, refers to an over-supply of blood to a part. The blood under normal conditions carries nourishment to the various organs and tissues of the body. The demands within physiological limits are not always uniform and if there is an over-supply to a part, that part is called hyperemic ; if there is too little blood the part is anemic or ischemic. If we get beyond these physiological limits, the condition becomes pathological. This condition of the blood supply, if it occurs as a general bodily condition, constitutes plethora on the one hand, or anemia on the other.

Hyperemia from a pathological standpoint is known as active if due to an increased arterial blood pressure, or if due to a venous obstruction it constitutes passive hyperemia or venous congestion. The active hyperemia gives to a part

symptoms of bright redness, some heat, and more or less well-marked diffuse swelling. Venous congestion, not being so abrupt, gives a blue-red dull blue or mottled appearance to the part, little or no heat, and an amount of swelling commeasurate with the obstruction.

**Ischemia,** or anemia, in a part is due to a narrowing of the lumen of the artery supplying the part. Such a narrowing may be vaso-constrictor, or may be due to a partial narrowing (atheroma) of the lumen or to occlusion (embolus or thrombus) of the artery. Following such incomplete blood supply to a part there are symptoms of pallor, and a dull flabby appearance. After occlusion of the arterial supply the part is cut off from its nourishment and begins to undergo tissue degeneration. If total this is known as necrosis, or death, of the area involved.

If the causes of either the hyperemia or ischemia are soon remedied, a part returns to its normal and physiological condition. Otherwise we overstep and have inflammation.

**Inflammatory Exudates** vary somewhat according to the type of the inflammation ; whether acute or chronic ; whether mild or severe ; whether of simple or traumatic origin or are due to an organism of virulent nature. They vary somewhat in that the area involved may be small or large, and especially according to the tissue or viscus which is the seat of the inflammation. In all cases the amount of blood vessels involved and the mode of involvement determine whether the inflammation is of low grade character or of extensive or virulent type.

A **Serous** exudate consists largely of the clear transudate, serum, and contains few cells. It is of low grade, is

apt to be sub-acute, and usually contains little albumen. If it is in the skin or mucous membrane and shut in by the restricting surface layers it causes blisters or vesicles. If within a viscus it may constitute cysts, or edema of the viscus.

A **Fibrinous** exudate is formed by the breaking down of leucocytes and liberation of the fibrin ferment. This acts upon the fibrinogen of the serum to form fibrin. This fibrin, or fibrinous exudate, may appear in flocules floating in the serum ; or as flecks, granules, or villous patches upon surfaces ; or in sheets. If considerable in quantity it is apt to undergo fibrillization and form fibrous connective tissue.

By **Sero-fibrinous** is meant an exudate in which the serous type is the greater but which also contains fibrinous material. It is used variously to mean a mixed type with varying quantities of the two component elements.

A **Croupous** exudate is a fibrinous exudate, usually formed upon the surface or extending but a short distance into the cell layer of a mucous membrane. The fibrin forms in layers and catches in its meshwork leucocytes and desquamated epithelia and occasionally red blood cells, if the inflammation is abrupt as in pneumonia.

A **diphtheretic** exudate consists of one remove farther. The fibrinous exudate extends upon and between the cells and beneath the cell layer of a mucous membrane and chokes off the blood supply. There follows coagulation necrosis, sloughing of the membranous cell layer with accompanying bleeding from the underlying basement tissue.

By **hemorrhagic** exudate we distinguish one, of abrupt formation, in the serum of which the red blood cells are in large quantities. Usually there is associated a serious condition of the capillary walls, if not of the general bodily condition as well. If a hemorrhagic exudate takes place acutely in a mucous membrane it is frequently termed rhexis.

A **Suppurative** or purulent exudate consists of serum with a large quantity of leucocytes. It may be thin and milky, or thick and creamy ; and if it appears upon the surface of the body is known as pus. When it appears upon a mucous membrane it constitutes purulent catarrh ; in a serous cavity, an empyema ; beneath the superficial layers of the skin a pustule ; deep in the tissues, an abscess ; upon the open surface, an ulcer. If it infiltrates tissues diffusely it is termed purulent edema ; and if it involves large areas it is known as phlegmon. If such purulent exudate undergo putrifactive changes it is known as putrid or ichorous exudate.

The origin of these pus cells is the leucocytes, the proliferated fixed connective tissue cells, and possibly derivative cellular elements from the stroma.

**Types of Inflammation** have been in part discussed under exudates. The acute inflammations in general may be characterized as exudative ; the chronic as productive. The acute inflammations of *connective tissue* are serous, sero-fibrinous, fibrinous, purulent, or haemorrhagic and are characterized by corresponding exudates. They tend to return to normal, or become chronic with formation of productive tissue. The acute inflammations of *mucous membrane* are catarrhal, purulent, croupous, diphtheritic, or necrotic (rhexis), with formation of corresponding exudates. They tend with the possible exception of necrosis (or rhexis) to return to normal without special loss of substance or increase in productive tissue formation. In *viscera*, the acute inflammations are parenchymatous or interstitial or necrotic. They return to normal, or complicate with inflammations of one or other or all of the preceding classes, or not infrequently become chronic.

The chronic, or productive, inflammations follow certain types depending upon whether they occur in connective tissue, mucous membrane, viscus, bone, blood vessel or nerve ; and are simple, or with exudate. They follow the acute inflammations where there is large death of tissue as in abscess, or where large masses of exudate interfere with early repair as in pleural adhesions. They are caused by constant and continuous injury such as dust in miner's lung, by unfavorable nutritive conditions as insufficient blood supply to a part, by repeated bacterial infection, and by repeated autointoxication. They constitute chronic ulcers, chronic granulations, or cirrhosis. In cirrhosis there is hypertrophy of the connective tissue elements and an atrophy of the special tissues, be the tissue viscus, bone, vessel, or nerve.

**Repair** of an inflammation takes place by a sort of inverse process. The various exudates are liberated by the surgeon by operation and drainage. Or without operative interference, they undergo granular or fatty degeneration of their cellular elements and are taken up by the blood and lymph channels and are cast off in the bodily excreta. The fibrous varieties undergo a similar process of degeneration and absorption, or are left behind as thickenings of fibrous tissue. The serum is taken up in the blood and lymph channels. The newly formed blood vessels gradually lose function, atrophy and absorb, or are obliterated by the pressure of the fibrous connective changes in the part. The cells of the part take on regeneration processes, and cell by cell the tissues reproduce their kind directly or through the mediary of cell proliferation. Or there is formation of and increase in new connective tissue, or granulation tissue, and the parts return to normal. Or they result in parenchyma-

tous or interstitial thickenings and consequent destruction of cells and stroma.

**Inflammation Reaction=Fever.** — Following any wound or inflammation there is a certain amount of cell reaction. This is termed fever. It may be defined as a disease, or symptom of a disease, characterized by elevation of temperature and accompanied by a disturbance of circulation, increased tissue waste and altered secretion.

**Lesion.**—Either by means of the absorption of the fibrin ferment, of leucomaines tomaines or toxins,—or in case of the hysterical temperatures by some means as yet unknown,—into the blood the heat centers in the medulla are irritated and stimulated. Secondarily the vaso-constrictor action upon the heart and blood vessels is set in motion.

Fever may be caused by absorption of the products of pyogenic bacteria as in septicemia, or by decomposition of the nutrient media of the blood as in insolation, or by putrifactive toxins as in the autotoxemia of constipation, or by fibrin ferment as in large hematoma associated with severe fracture, or by hystocym of normal metabolism, or by solutions of hemoglobin in blood extravasations, or by certain blood decompositions as are found in connection with Lister's use of phenol spray in aseptic wound fevers, or by ptomaines or leucomaines of putrifying food products such as fish, shell-fish, milk, cream and cheese.

**Symptoms.**—The constant symptom, or characteristic, is the elevation of temperature or the increase in specific heat. By means of a recording thermometer placed for convenience under the tongue, or in infants and children since they are largely mouth-breathers placed in the axilla, we are able to obtain the maximum temperature of the

body. The normal is approximately 98.6° F. In a slight fever this will rise to 101.° to 102.°. A continued fever like typhoid or pneumonia will maintain an evening temperature of 104.°; while in septicemia or insolation it will often rise to 106° or 108°, in which case the temperature is termed hyperpyretic, and is symptomatic of almost immediate dissolution. Following death, putrification changes take place especially in the obese, and these so-called post-mortem temperatures often rise to 107.° and 110.° and higher.

In association with a rise of temperature in fever, the pulse is quickened, is fuller and bounding. Later in the course of the fever it becomes still more frequent but grows smaller and feeble. It may become in the later weeks of continued fever so feeble as to be denominated wiry, or gaseous, or so imperceptible that it is not to be had at the radial. Depending upon the virulence of the fever the pulse will rise from 70 to 90, 100, 120, or even to 140 and 160 per minute. It is not always commensurate with the rise in temperature. In children, we expect a sharp abrupt rise in temperature and in pulse. In old people the pulse is often very high with temperatures normal or nearly normal or even subnormal.

There is often an associated increase in number of respirations, especially in children and very old people.

A fever is usually ushered in by a chill, or sensation of coldness. The more abrupt the rise in temperature the more marked the chill, even amounting to a rigor. If the temperature rise is very gradual, covering several days, the chill is often absent. Even during the chill period the temperature is often rising.

After the fever is once established, there is usually a fall in temperature from 5 to 8 A. M. known as the morning defervescence. The time of maximum temperature is from

4 to 7 P. M. and is known as the evening exascerbation. This is characteristic of most continued fevers. The course of such a fever typically terminates in one of two ways; gradually or by lysis, or abruptly by crisis. With lysis, we frequeutly find that a patient begins to have profuse perspiration, showing his general bodily weakness or inability to react. So in crisis, it is not infrequent to have a complete collapse and subnormal temperatures for several days.

The increase in specific bodily heat is caused originally by the stimulation of the heat centers in the medulla and the irritation of the vagus. More heat waste is caused and more katabolism takes place. Due to the irritation of the vagus there is at first a vaso-constrictor action upon the surface capillaries and a corresponding lack of heat radiated. This lessened heat loss is maintained later, when the vaso-dilator action affects the capillaries, by a concurrent decrease in blood current to two-thirds its former rate. The circulation of the blood in the capillaries is retarded, there may be stasis. The pulse is hard or soft in fever according to the blood pressure. The heart late in fever may be so feeble as to give a dicrotic pulse, an unfavorable symptom. With retardation of blood current, the various glands and viscera have inadequate blood supply and there follows altered secretion, usually diminished. With increased respiration there is increased metabolism and production of carbon dioxide. To maintain this, a fifth more of oxygen is needed to be inspired. The respiration early is full and deep, late is feeble and shallow. The patient is restless and irritable or languid and depressed at the beginning of the fever. This succeeds to a condition of general mental depression, delirium, or coma, as the temperature remains high. And finally we may have general clearing up of the mental horizon in favorable cases, or a relapse rarely into chronic mental disease. The digestion is regularly enfeebled throughout the

fever course. The onset is regularly marked by nausea or vomiting or both. There is lessened appetite and little or no peristalsis throughout. The tongue is coated. There is marked thirst. The perspiration is lessened, the skin dry and hot. The urine is diminished and loaded with phosphates and urates and not infrequently peptones and albumen are present. There is increase in specific gravity. The patient complains of general weakness, is tired, and occasionally has muscle-pains. The body gradually diminishes in weight due to the waste of tissue elements, usually the katabolism of the albumen and the fat. The glands and muscles undergo parenchymatous degeneration, the sebaceous tissue fatty degeneration.

**Prognosis** of fever is based largely upon the height of the temperature rise, the increased and enfeebled heart's action—*i. e.*, upon the patient's katabolism—upon his mental optimism and the severity of the type of infection. A patient dies when he loses forty percent of his bodily weight, estimating katabolism to be .007 parts per day. Thus in a continued fever a temperature of 104.° could be maintained for eight weeks. Fatal cases are otherwise due to too high temperature, or the subnormal temperature of collapse, to general weakness, degeneration of the heart and its vessels, or to virulence and quantity of the bacterial poisons.

**Treatment** of fever consists first in prophylaxis or protection from and avoidance of the disease. In case of wound-fever due to infection and non-drainage of the retained secretions if the temperature rise to 100.° or 101.° the dressings should be changed. Antiphlogistics, such as elevation of part, the application of ice or evaporating solutions may be indicated; cooling drinks and liquid diet are to be given. Antipyretics and stimulants such as acetanelid and whiskey may serve to make the patient more

comfortable. A liberal and frequent use of the saline laxatives may be of service at the beginning of the fever to promote excretion and secretion, and may be continued from time to time throughout the disease.

## INJURIES AND WOUNDS.

By **injury** is meant damage to a part. The simplest injury to soft parts is termed *suggillation*. Due to traumatism of, or a blow upon, the part there occurs disruption of the smaller blood vessels within the skin, perhaps extending to the underlying cellular tissue. There may be some slight disturbance of tissue elements. In main there is produced a considerable capillary hemorrhage. The part at first is red, painful and swollen. After a few hours the swelling and pain is markedly increased and the escaped blood elements give the part a blue-red to dark blue tinge. After a few days the heat pain and swelling subside, the absorption of the blood elements begins to take place and the part becomes mottled with varying shades of red, green, yellow and blue. In exceptional cases, due to rupture of large capillaries a typical hematoma or blood tumor is formed, with all the symptoms exaggerated. It is easily infected at the time of injury and later and may become purulent. Rarely in hemophilia, we have aggravated further the condition and symptoms.

Treatment is continuous applications of cold for one or two days to cause contraction of surface capillaries, followed by heat of 110° applied interruptedly to further promote absorption of the exudate and to relieve pain.

**Contusion** is a bruise or an injury by a blunt weapon without rupture of overlying skin. It may be simple, with

preservation of the integrity of the underlying parts, or be complicated by disturbance of their integrity, and necrosis follow. There may be extravasation of lymph and blood. There may be hematoma. Temperature may rise exceptionally to 102.° to 104.°, due to ferment intoxication or fat embolism. There is pain, disturbance of function. There follows absorption of the blood elements, or organization of the blood clot, or the clot may dry or suppurate or in rare cases calcify. Treat by heat or cold, and after three to five days by massage. The various movements of stroking friction and kneading may be used as needs demand.

In association with contusion, subcutaneors rupture of muscle or tendon may complicate. At other times there may be dislocation of muscle or tendon. These demand reduction and fixation and a relatively longer time for repair.

A **wound** is a solution in continuity of soft parts due to external violence or trauma. There is caused wound pain due to division of the superficial sensory nerves and the subsequent pressure of the inflammatory products in the wound edges. The sharper the instrument and the cleaner cut the wound the less the wound pain. There is pretty uniformly hemorrhage. The cleaner the wound, the quicker the blow, the sharper the instrument, the less damage is there done to the coats of the blood vessels and the more profuse the hemorrhage. The larger the blood vessels cut the greater and the quicker the blood loss. The wound edges gape due to the contractility of the now free skin edges. If there occur a severe loss of blood, enough to cause dizziness and weakness, this may be overcome within 24 hours by rest and the ingestion of large quantities of water. The quality of the blood, the reproduction of the red blood cells, is accomplished only after 10 to 25 days. There may be accidental entrance of air into

the veins, and direct to the heart, that may cause immediate death. There may be division of muscle and tendon requiring suture; or rupture or division of nerves causing paralysis or degeneration, this may require suture at an immediate or a remote time in order to repair trophic conductivity or clear up degenerated nerve bundles.

Wounds are variously denominated. An incised wound indicates edges clean cut by a sharp instrument, or by a blunt instrument, quickly struck over some underlying resisting part such as bone. By contused wound is meant a complication of wound with bruising of the surrounding tissues. A lacerated wound indicates a mangling or tearing of the wound tissues. A penetrating wound is one in which a cavity is perforated. A complicated wound indicates one in which the injury is complicated by a fracture, severe hemorrhage and the like. A wound is clean or infected depending upon the absence or presence of bacterial infection. Punctured wounds give a relatively small area of surface injured as compared to the amount of damage possible to be done in the deep tissue and vessels. Vein and artery may be injured and marked hemorrhage follow, deep in the tissues ; or nerve, joint or cavity may be punctured, with infection, or healing spontaneously with the healing of the wound. Traumatic emphysema due to putrifactive changes may follow deep infection in a punctured wound. Contused and lacerated wounds do not bleed on account of general injury to the surrounding parts. Punctured and lacerated wounds may bleed severely at the time of injury ; or secondary hemorrhage may follow in any or all these if infected and carelessly treated.

Treatment consists in stopping all hemorrhage by pressure, ligature or hot compresses, cleaning out the wound and apposing the surfaces so far as possible in order to obtain primary repair. In large lacerated wounds it is

necessary to repair any considerable loss of substance secondarily, by granulation. If foreign bodies, such as glass bullets or cloth, are present in a wound, clean them out even if necessary to enlarge the wound to do it. Drain all corners and pockets not possible to obliterate, suture wound edges so far as possible and apply suitable dressings. Amputation is done only when absolutely necessary.

**Secondary hemorrhage** is an unfavorable complication and is uniformly due to more or less extensive suppuration and associated with burrowing of pus. Clean up the suppuration and avoid the hemorrhage ; but if unavoidable, be upon guard and ready to ligate a proximal artery when necessary.

For severe hemorrhage, **hypodermoclysis** is made use of to save life. By means of a large hypodermic syringe two to five ounces of a normal salt solution, 6 to 7 percent, warmed to body temperature are injected at one time in the large lymph spaces of the breast, abdomen, groins or back. This is repeated until there is relief from the symptoms of the acute anemia.

**Healing of Wounds.** Following an injury or a wound the repair process is similar in each. *Primary healing* is that which takes place in a simple non-infected injury in which there has been no productive inflammation nor loss of substance such as follows abscess. It is that which also takes place in a simple clean wound in which all hemorrhage has been stopped and in which adjacent edges have been brought in close apposition by sutures or compresses. In the same way we speak of *secondary healing* of an infected injury or one in which productive inflammation is had ; or of an infected, badly managed and open wound. In pri-

mary healing of an injury or wound the return of the tissue to normal is by a process of absorption of the serum and the broken down blood and proliferated connective tissue elements and the obliteration of the blood vessels. Secondary healing follows a different course.

**Histology of Secondary Healing.** After the formation of blood elements outside the vessels, and a certain amount of tissue-cell proliferation, there is a more general cell infiltration of the tissues. The wander cells take on the habits of germinal tissue and there is general invasion of the borders of the wound or injury. In the cells of the old tissue there is considerable central fatty degeneration and death and absorption. In about three days many new round cells are formed. These soon enlarge and elongate into epithelioid or formative cells that have one or many nuclei ; and which are variously known as cicatricial, granulation tissue or fibroblastic cells. These fibroblasts on about the fifth day begin to form fibrillar connective tissue. In a similar way instead of fibroblasts there are formed osteoblasts, chondroblasts, sarcoblasts, that produce in turn bone cartilage and muscle.

At the same time the fixed connective tissue cells begin a regeneration process, the leucocytes degenerate and absorb, or go back into the blood vessels. The epithelial cells of the blood vessels proliferate and new blood vessels are formed within the new fibrous connective tissue or scar tissue. The lymphocytes cover the newly formed lymph spaces with epithelia and the part gradually returns to normal, with the formation of a scar or cicatrix. This scar may be red if it contains many new blood vessels, or white if its bulk is largely made up of fibrous tissue without blood vessels.

Before the formation of new blood vessels the early nourishment of the part is maintained by the plasma stream. Thrombosis, or plugging, of the broken or contused blood vessels has cut off the normal blood supply to the part. In a similar way in the use of skin grafts for the repair of denuded surfaces, for about three days the nourishment of the skin patches is carried on by the underlying plasma supplied by the vessels of the underlying tissues. Later there is formation of permanent blood vessels concurrent with this same process of secondary healing until in about two weeks the skin becomes firmly attached by fibrillar connective tissue.

**Granulation Tissue.** In cases of large loss of tissue from any cause an open wound is said to heal by granulation. From the base of such a wound this process of secondary healing begins. After a day such wound is bathed in blood serum and lymph and is grey in color. After 3 to 4 days new blood vessels rise in tufts and around each tuft the fibrillar connective tissue aggregates so as to give an appearance of bright red pulpy points or granulations. At their base they change to fibrous tissue ; on the surface they are bathed in lymph and pus. Touched, they bleed very easily and are very sensitive. Gradually this formation approaches the skin surface and at the edges there begins a process of skinning over. This skinning over of a granulated wound is brought about through proliferation of the cells of the malpighian stratum or of the epithelia of the sebaceous glands of the skin, or both. In the event of large granulating areas, the process of skinning over would be too slow and advantage is taken of making Thiersch skin grafts, before referred to. Auto-grafting, peculiarly gives surest results. Finally granulation gives way to cicatricial tissue

or cicatrix. This cicatrix often undergoes cicatricial contraction especially when the fibrous element is preponderant as in burns, and causes bad scarring ; even contractures take place. In many or most cases the tissues are reproduced in like, as bone by bone, muscle by muscle, cellular tissue by cellular tissue, until at the surface the skin reproduces itself by extension from the old skin edges.

**Thrombus.** Normally the blood is fluid and in constant motion. For the production of a thrombus, or plugging of a blood vessel, it is necessary that there be both a rupture of the endothelial lining of the vessel and stasis. This happens in practically every injury and wound. Thrombus may be partial if formed in an eddy ; or concentric if the occluded vessel, later, gradually and intermittently enlarges ; white, if they contain few red blood cells and form slowly ; or red, if they form quickly and imprison many red cells ; or mixed, if they are at various points made up of both red and white.

Following a break in the intima of a vessel, fibrin ferment is liberated and fibrin is formed. The blood plaques agglutinate over the point of ruptured intima, fibrin forms rapidly catching often in its meshes the leucocytes in considerable quantities and less frequently the red blood cells. Such a thrombus occludes the vessel, and at a little later period is seen to consist of granular masses, fibrin and varying proportions of white blood cells. The fibrin consists of granular or stringy fibrin. The granular, often hyaline, masses are formed from the agglutinated blood plates and possibly from the leucocytes. After formation of the thrombus, organization takes place, there is formed connective tissue, and cicatrization. If the thrombus be of considerable size vascularization or proliferation of the endothelia of the

intima follows and new blood vessels are formed. This process varies according as it takes place in the young who have quick repair, or in the old where atheroma and chronic tissue changes interfere with regeneration. Essentially organization and vascularization in the larger vessels may be said to take place in from one to two weeks while regeneration and return to normal takes two to three weeks longer. As an aid to the repair process, collateral circulation in the injured part is aided by a reduplication of the smaller blood vessels or vasa-vasorum. This formation occurs at about the sixth day and is due to both an hypertrophy and a hyperplasia of the endothelial elements. This increased circulation causes increased flow and increased nutrition in the part.

## BACTERIA.

**Bacteria** are a microscopic group of fungi that cause fermentation, putrification, infection, disease or death. They occur singly and free and are round (cocci), or in straight rods (bacilli) or in twisted rods (spirilli); or are placed in packets (zoöglea); or they form filaments (as streptococcus); or group in grape-like bunches (as staphylococcus). They depend upon free oxygen and are termed aerobic; or are anaerobic, oxygen is not essential. They propagate either by endospores, develop spores within their cell walls; or by arthrospores, specialized segments of a chain; or they multiply by fission. They are known as liquifactive or not according to their power of liquifying nutritive media. They are motile or non-motile as determined by their power to move about or not. Saprophytic bacteria live upon decaying organic matter and flourish best at a temperature of

68° to 77°; while parasitic bacteria exist in and upon living tissues causing disease often and grow best at 95° to 104°. Those that cause fermentation are called zymogenic ; those that cause disease are pathogenic. The term bacteria is practically synonymous with microbes, micro-organisms, germs. The products of bacterial metabolism are variously grouped under the heads of ptomaines, nucleins, proteins, cadaver alkaloids, toxalbumens, and toxins. They are generically known as toxins and are often poisonous. The bulk of the bacteria grow best in alkaline or neutral media containing nitrogen in the form of albumen and carbon as sugar or glucose. Direct sunlight will kill many bacteria within a few hours, such as those of typhoid and tuberculosis. The germ of anthrax resists for a longer period. Dry heat and especially moist heat at high tempertures destroy them ; while freezing kills most, save possibly typhoid and anthrax. The high and low tension electric currents seem to have no effect upon them.

To a degree bacteria have the power of gradual adaptation to unsuitable media. If we grow pneumococcus, staphylococcus pyogenes aureus or anthrax, which normally are killed by solutions of mercuric chloride of the strength 1–15.000, first in 1–40.000 and gradually raise the proportion of the sublimate we can finally grow these germs in 1–2.000.

Similarly, the metabolic products, the toxins, are restrained by acids such as carbonic, acetic and lactic or by the stronger alkalies. These toxins are given off through the germ wall and are contained in the media, or are retained within the thick cell wall, as in tuberculosis and typhoid, and are only liberated after ingestion of the germ. Heat usually destroys them.

Variation in media give varying virulence of most toxins. Certain chemicals differentiate the bacterial pro-

ducts ; alcohol precipitates the diastases, acidified alcohol the toxalbumens, Millon's reagent (mercury) the peptones, lead and mercury the ptomaines and alkaloids. Bacterial death in the laboratory is caused by certain growth limitations such as temperature rise or fall or variations, by excess of water, by certain chemicals or poisons, or by the very limitations of bacterial growth and accumulation of their own tóxins.

The bactericidal action is best tested by means of loop-drops or threads saturated with a culture. The germs are variously grown in test tubes, fermentation tubes, flasks, or in Petri plates. These may contain fluid media such as bouillon, milk, and serum, or on semi-solids as gelatin agar, or on solids such as potato.

A germ is said to be capable of transmission when it transmits a disease from one person to another. It is inoculable if when placed in the living tissues it causes disease. The process of placing it in the tissues is termed inoculation. Toxic bacteria and their toxins regularly develop outside the body and are poisonous in proportion to the amount of toxin given off into the body. Infectious bacteria develop and increase in the body. A relatively small number of infectious germs rapidly multiply, with a corresponding increase in the poison products, causing general poisoning of the body. The virulence of a germ is attenuated or weakened by changed conditions or environment, such as sunlight, heat and antisepsis. The body tissues are protected in part since the blood serum is germicidal to many bacteria, the white and red blood cells are antagonistic to them, the alkaline salts of the blood and its temperature (98.6° to 104°) is inimicable. Possibly the leucocytes have a certain power of phagocytoses in some cases, but the rule is that the white blood cells die in the unequal fight with the bacteria ; and, as the bacteria are ingested and carried off by

the cells, they are already dead and are simply in the process of being excreted through the feces, urine and saliva.

Immunity from a germ or its disease may be said to be natural or acquired. It is acquired, if by inoculation of a weakened virus or bacterial poison, the body cells finally become able to resist the action of the germ or its toxin. Example of this is the immunity conferred by vaccination and by diphtheria antitoxin. Natural immunity is caused either through exhaustion of food products in the body cell; or through retention of bacterial products in the body cell, causing it to resist a second attack by a germ or its disease. Or perhaps both these exhaustion and retention theories are necessary to explain all the facts. Examples are yellow fever and typhoid. The cell, and not the tissue nor viscus nor body, has the power of immunity. Artificial immunity may be subserved by certain chemical changes such as the addition of fibrinogen or pleural exudates or toxins to the culture, or certain chemicals as iodoform. Use may also be made of the known antagonisms of various bacteria, as bacillus prodigiosus in protecting rabbits from anthrax.

**Serum Therapy** is the treatment of disease by injection of sterilized blood serum from immune animals.

In tetanus this immunity is accomplished by injection into the horse of small amounts of pure cultures of the tetanus bacillus weakened by the addition for instance of trichloride of iodine.

In anthrax use is made of bacillus prodigiosus to cause immunity.

In typhoid for immunizing horses, various types of typhoid serum are used and the resulting antitoxin is most efficient upon its own type of bacillus. This is proven by agglutination tests. In certain cases the typhoid antitoxin

is made more efficient by the addition of colon antitoxin. Ewing claims of typhoid that the best results will be gotten from a bactericidal serum rather than from an antitoxin.

Coley in his serum therapy of cancer has made use of the mixed toxins of streptococcus of erysipelas and bacillus prodigiosus, giving this sterile serum by hypodermic deep in the lesion in small and repeated doses. He has gotten some good results especially in inoperable cases.

Serum therapy has been used in India in the case of bites from certain poisonous snakes, making use of serum immunized by the various poisons.

Yersin has developed an antiplague serum. The serum of an infected animal or man, in over three hundred cases of one observer agglutinated a fresh emulsion of the bacillus. In many of these cases Yersin's serum given subsequently had little effect, and temporarily, but when given intravenously had its best results.

This variation is shown also in Widal's reaction where different races of the typhoid bacillus give different reactions. Romberg had similar results in using tubercular emulsions. The same is true in using the Pfeiffer reaction in cholera. The results are not uniform. Different species vary in virulence and agglutination power. In accertaining values of a serum its agglutination power is an estimate of its power upon the special bacillus or disease. It is however difficult to estimate the importance of reports of cases, as to strength of the serum and the mode of its preparation, the type of the disease and the type of the individual. The antitoxin or the serum must operate first through its inhibitory action upon bacterial growth and second through its antitoxic effect upon the bacterial metabolism. It is known that normal serum alone, containing its alexin, is capable to a degree of accomplishing these results. It is also evident that immunizing serums operate chemically. Anti-

toxins have been developed for both vegetable and animal poisons, for arsenic, and still others that are antagonistic to pepsin digestion. Normal serum is often as good as special immunizing serums; it supplies a deficiency in a certain complimentary substance. This may explain the mode of operation of diphtheria antitoxin in pneumonia, antistreptococcus serum in sarcoma, prodigiosus serum in anthrax.

In diphtheria where there is known to be a wide variation in both the toxicity of the Klebs-Loeffler bacillus and its power to set up inflammatory reaction, the best and most invariable results have been gotten. In the way of prophylaxis, an immunizing injection of a weaker antitoxin is given, and this gives protection for two weeks or longer. At the outset of the disease 2,000 units of the antitoxin are given at once without waiting the results of bacteriological investigation. This is repeated in 12 hours, time. Children take larger doser than adults. Laryngeal cases demand 4,000 units, repeating 2,000 units in 8 to 12 hours. Many physicians give at once 5,000 units and repeat smaller quantities as the progress of the disease indicates, believing that the excess of the antitoxin does no harm save a slight reaction fever and an occasional rash. Values depend upon early exhibition of the serum and the relative large amount of antitoxin units used in the severe types of the disease. By its use various authorities report a great reduction in the death rate from diphtheria. Cuno reports 7 years' experience and a reduction from 36.7 percent to 9.4 percent mortality. Jelnick in Austria reports 17,000 cases cared for under ordinary treatment with 39.3 percent of deaths, and 15,000 cases where serum treatment gave only 15.8 percent of deaths. He reports also 7.6 percent of deaths where the serum is given upon the first and second day as opposed to 15.6 percent when given the third day of the

disease. In this country slightly better results have been had than these given above.

In the matter of experimental transmission of a disease, in order to prove any theory of causation, it is agreed that there are three steps necessary for proof. First, the bacteria of a disease must be determined and gotten. Second, the germ must be cultivated outside the body in an artificial medium. Third, the germ must be reinoculated into the body and produce the disease and all its symptoms. The technique of these steps requires a certain amount of dexterity and skill. The germs are gotten from an animal, postmortem, without admixture of other germs and determined. In the laboratory they are grown perhaps, in their own particular media. If contaminated they are cleared through plate culture and grown in pure culture. Finally with care and cleanliness they are inocculated back into an experimental animal. If that animal succumbs to the original disease, we have proved our germ.

The principal pathogenic bacteria are: 1. Anthrax bacillus (Pollender and Davaine). 2. Bacillus of green pus (Gessard). 3. Bacillus of spreading edema (Koch). 4. Cholera spirillum, or comma bacillus (Koch). 5. Common colon bacillus, or bacillus neapolitanus (Emmerich). 6. Diphtheria bacillus (Klebs-Loeffler). 7. Glanders bacillus, or bacillus mallei (Loeffler). 8. Gonococcus (Neisser). 9. Lepra bacillus (Armauer and Hansen). 10. Micrococcus of chancroid (Ducrey). 11. Paracolon bacillus of pseudotyphoid (Gwyn). 12. Pneumonia bacillus (Friedländer). 13. Relapsing fever spirillum (Obermeier). 14. Septic sputum bacillus (Flügge). 15. Staphylococcus pyogenes albus, (Rosenbach), 16 aureus (Rosenbach), and 17. citreus (Pesset). 18. Streptococcus pyogenes (Rosenbach), and 19. of erysipelas (Fehleisen). 20. Syphilis bacillus

(Lustgarten). 21. Tetanus bacillus (Nicolaier). 22. Tubercle bacillus (Koch). 23. Typhoid bacillus (Eberth).

Allied to these are 1. spirillum of Deneke, or vibrio proteus of putrifaction and 2. the plasmodium of malaria, a protozoan.

Of pathogenic bacteria of animals there are: 1. Bacillus of hemorrhagic septicemia, or chicken cholera, (Sternberg). 2. Bacillus of southern cattle plague (Billings). 3. Bacillus of swine erysipelas, or mouse septicemia (Pasteur-Loeffler). 4. Bacillus of swine plague, or hog cholera, (Salmon and Smith). 5. Bacillus of pseudo-edema of mice (Liborius). 6. Micrococcus of foot and mouth disease of cattle (Schotellino).

## SUPPURATION, SEPSIS, SAPREMIA, TOXEMIA, AUTOINTOXICATION, AUTOTOXEMIA, STARVATION—ULCER, ABSCESS, GANGRENE.

Sepsis, sapremia, toxemia, autointoxication, autotoxemia, starvation, ulcer, abscess, gangrene.

**Suppuration** is the formation of pus. It is usually caused by bacteria, but may occur exceptionally without their presence in a wound. It is caused experimentally by injection of chemicals or by inocculation of sterile cultures of bacteria or of their toxins. The typical causal bacteria are the staphylococcus pyogenes aureus and albus, and the streptococcus pyogenes ; and by the pus cocci, bacillus pyocyaneus, the bacillus of spreading edema, the pneumococcus, and the typhoid colon and paracolon bacilli. These bacteria destroy the tissues rapidly, forming large collections of pus. The pus contains in solution the poisonous toxins. The bacteria are seldom in the pus but lie at the borders of

the pus cavity between the cells of the broken down tissues. Accompanying such a local pus collection there is often a rising general leucocytosis in the blood stream. This is made use of by surgeons as an indication for operation. If the leucocytes in the first two days reach 15.000 to 20.000 per cubic millimeter in the blood count it is an indication of an advanced pathological lesion. If this fall, there is a rapid cessation in the local lesion. If there is a high leucocytosis after four days it usually indicates a walled off abscess. An exceedingly high count as 60,000 indicates extreme septic infection.

**Sepsis** is a condition of absorption into the body of the toxins of pathogenic bacteria. It is analogous to septic intoxication and to septicemia. An allied expression, septic infection, refers to infection of tissues by the pathogenic bacteria. It is analogous to septicemia. Sapremia is the absorption into the body of putrifactive toxins. Toxemia constitutes absorption and retention in the body of toxins produced in body cells and not properly eliminated, or of toxins produced by bacteria. Autointoxication is self poisoning by toxins of katabolism, such as constipation and uremia. It is practically the same term as autotoxemia. For instance, as the result of not emptying an abscess, the toxic properties of the bacterial katabolism are absorbed. If not very severe symptoms are the result, the condition is known variously as sepsis, septic infection or septic absorption, or if more severe as septicemia. If the ptomaines of putrifying fish or cheese are retained in the body we speak of this condition as sapremia. If we have fever and its concurrent altered katabolism and secretions, nucleins are retained in the body, as in constipation, and these constitute a toxemia or autotoxemia, or autointoxication.

**Starvation** is katabolism of the body through lack of nutrition. The waste takes place in muscular and fatty tissue. It is dependent both upon inability of organs to perform their functions; and upon deprivation of food that is essential and capable of assimilation by the organs of the body. Katabolic products of bodily metabolism and toxic products of both putrifactive and parasitic bacteria interfere with glandular excretion and secretion and with the normal enzymes of digestion.

**Lesion and Causes.** The body lives upon its material elements. The glycogen is the first to disappear and that almost entirely. There is corresponding waste of both liver and spleen. Next the fat is used up and then the proteid of muscle. Upon death by starvation nearly all structures have suffered save the circulatory and the nervous systems. The brain, cord, nerve trunks, the heart and the vessels practically suffer no loss. If there is appreciable loss either in quantity of the blood or in the substance of the central nervous system there is almost immediate death. In engorgement of the mesenteric glands, cancer or stenosis of the pylorus or of the small gut, stenosis of the pancreatic or hepatic ducts, in severe septic and infectious fevers marked changes in digestive and glandular activities take place, the normal balance of metabolism is lost, and there is increased katabolism and starvation. Simple deprivation of food is rare, and occasionally causes starvation.

**Symptoms.** The face is emaciated and looks old. The skin is thin, bronzed or jaundiced, wrinkled or sunken into the depressions of the absorbed fat, or hangs in flaps. The eye is lustrous or may be pale and dull. The tongue is dry, brown, and may be cracked and bleeding. There is a little thick saliva. The teeth are covered with sordes. The breath and the exhalations have a peculiar odor, not unlike stale urine, that is pathognomonic of starvation.

The appetite, at first ravenous, fails after the second or third day and there is no painful craving, except after the ingestion of food. There may be slight nausea and bilious vomiting. The belly is flat and the abdomen empty and lying upon the spinal column ; or there is tympanites and borborygmus. There is regularly obstipation, in part due to flaccid abdominal muscles and in part to atonicity of the bowels. The movements, if any, are hard scybalous brown or black and very fetid. The bowels move only at intervals of one to three weeks. The pulse is very soft and slow. The urine is usually normal in amount, and late in the disease contains albumen. The urates and urea are markedly increased upon the first day and, gradually diminishing, are still increased above normal throughout the course of the disease. The heart's action is feeble and there is usually an anemic murmur. The temperature is subnormal and drops still lower as inanition increases. Or there are occasional slight rises of temperature due to no perceptible cause. The respiration is diminished in number and shallow. There is inability to move and to stand. The muscles are thin and flaccid ; and are painful or sore. The patient is mentally irritable and excitable, or is irrational. There is sleeplessness. Or there is semi-stupor and the patient sleeps the greater part of the time.

**Diagnosis.** It is important to recognize this condition in fevers. No trouble is experienced in making the diagnosis if we have the possibility of its occurence in mind.

**Prognosis** depends upon the cause. If it depends simply upon the lack of food, or upon the proper balance of food, or upon the obstipation, it ought to be readily cleared up.

**Treatment.** Removal of the cause, if possible. Balance the ration. Give raw beef carefully or easily digested food in small quantities at frequent intervals. Stimulate as

necessity demands. Clear up the obstipation by use of the rectal spoon and enemata and afterward by laxatives.

Suppuration in tissues may assume one of three types of local inflammation : ulcer, abscess, or gangrene.

By **ulcer** is termed superficial destruction of tissue leaving an open wound which must heal by granulation. The size, shape and depth of an ulcer is variable. The edges may be smooth or irregular, sloping or undercut. The base is smooth or rough. If the ulcer is of acute type the base is covered with red graulations that bleed easily and that are bathed in pus. If the ulcer is of chronic type, it is covered at the base with a greyish-red membrane and is bathed in sero-pus and surrounded with an indurated red edge. If the ulcer is of sloughing type, it has a grey base, without granulations, and is bathed in a small amount of lymph ; or if the ulcer is phagedenic, as noma, its process is insidious, invading all tissues and having little or no exudate. All ulcers leave a scar.

**Abscess** is deep loss of substance by a purulent type of inflammation. They are acute and chronic.

The *acute* abscesses arise from a given point of infection, uniformly deep seated and usually of metastatic origin. The tissue cells at the center, as a result of bacterial action, undergo fatty degeneration and liquify, the bacteria invade the outlying tissue, pus is thrown off into the cavity. This process continues naturally until the abscess atrophies or degenerates the superficial tissues at the point of least pressure, and the abscess discharges its fluid contents. An acute abscess is covered, depending upon its nearness to the surface, by an area of more or less reddened skin ; it is painful and fluctuates. Sooner or later in the attempt at repair it is

lined by granulation tissue and some fibrous connective tissue admixed. This constitutes its lining of so-called pyogenic membrane.

If *chronic*, the pus comes from some distant point, as caries of vertebral bodies in psoas abscess. This inflammation is uniformly of tubercular or traumatic origin and is called cold abscess. There is no overlying redness, no pain, though there may be pressure, and there is a firm non-elastic lining membrane consisting in small part of granulation tissue and largely of fibrous connective tissue. These abscesses contain large amounts of pus and cause little or no discomfort to the patient. They heal by granulation, especially if the original bone disease and the connecting fistulous tracts are cleaned up.

**Gangrene** is total death of a tissue or part. It is due to lack of nutrition, with or without infection, and is caused by venous congestion. After gangrene is once established, putrifactive changes or mortification take place quickly in the dead tissue. There may be an attempt at repair, as in dry gangrene, in which case granulation tissue is formed upon the borders of the lining tissue, an intervening layer of sero-pus is thrown off from them, the connective tissue (fascial) elements connecting the two tissues give way, and the gangrenous mass now black or blue green is said to slough off. There is left behind an ulcer that must heal by granulation. In progressive or moist gangrene there is no line of demarkation. The process gradually involves the whole limb and trunk, if not interfered with, and the patient dies of sepsis or exhaustion. The skin surfaces are mottled blue and dark red, the underlying tissues are edematous, boggy and phlegmonous. The limb is without function. The remedy of amputation, far in advance of the gangrenous area, must be had early in order to stop the inevitable

progress of the disease. Such amputations are not sutured, but loosely dressed and allowed to drain thoroughly.

## LYMPHANGITIS.

**Lymphangitis** is an acute inflammation of a lymph vessel.

**Lesion.** It may begin as the slightest skin abrasion, through which infectious bacteria gain entrance and lodge in the deeper tissues. There are caused changes in the lymph, in the walls of the lymph vessel and of the perilymph spaces similar to those of any simple inflammation ; there is lymph thrombosis. There may follow, provided the type of infection is severe, destruction of the endothelium, necrosis and suppuration. Or there is absorption of the exudate and regeneration of the endothelium and a return to normal. Occasionally lymphangitis is chronic. Here there is hyperplasia of the connective tissue elements, and induration of the lymph vessels and the surrounding tissues.

**Cause.** The site of the original wound cannot be found, or if found may be seemingly healed, or may have an angry appearance as of an infectious inflammation. If this wound be on a finger, higher up upon the hand and wrist, the tissues after three to ten days begin to be puffy, swollen and tender. If the lymphangitis is progressive, this condition extends on up the forearm and arm, and light red streaks appear in the course of the main lymphatic channels. The amount of distention of the skin and subcutaneous tissues may be sufficient to press upon the veins and nerve trunks and cause additional swelling and dull and persistent pain. There is now considerable local heat

in the part and there is decided loss of function. The patient begins to have constitutional symptoms such as headache, nausea, anxiety, sleeplessness, loss of appetite and constipation. He is sick.

**Complications** may take place, such as abscess formation, along the track of the lymph vessels, rising at some point where the pressure produces stasis, as at the valves or in the lymph nodes. There may be inflammation by extension into the deeper cellular tissue, and cellulitis takes place, usually of local type. Exceptionally metastatic abscesses are formed.

**Treatment.** The primary focus of infection must be found and thoroughly cleaned out. The whole hand, wrist, forearm or arm must be kept swathed in strips and sheets of cotton or cheese cloth wet in ½–1 percent of phenol. This is usually preferable to 1–5,000 of the sublimate in these infectious wound diseases. Over this antiseptic poultice, oiled muslin or silk is wrapped and bandage applied. This dressing should be placed well in advance of the inflammation, should be renewed two or three times a day, and kept perfectly moist or wet. The arm is elevated and kept quiet. Saline laxatives and hot fluid diet will relieve the remaining symptoms.

If the lymph nodes at the wrist, the epitrochlears, or the axillary nodes become involved we have **lymphadenitis.** Over the inflamed nodes the skin is hot, red and swollen; the nodes themselves are greatly swollen and very painful; they quickly undergo suppuration and form abscess. If gotten in time, by the continuous application of an ice bag this purulent type of inflammation may subside and return to normal, or with the nodes slightly enlarged by connective tissue growth. Or it will be necessary as soon as fluctua-

tion appears to incise, scrape, drain and dress them antiseptically.

The lymphangitis will last from three to ten days, the lymphadenitis slightly longer. Persons once having this infection are apt to have it recur from seemingly slight cause such as the simplest abrasion. Lymphangitis may occur independently of lymphadenitis, or vice versa; or both occur together, in which case lymphadenitis is secondary to the lympangitis. They may happen at any point of the body but more especially in the upper and in the lower extremity. In practically all cases the original infection point can be found. This point and its strictly antiseptic treatment is of first importance.

## ERYSIPELAS.

**Erysipelas** is a specific dermatitis due to the erysipelas streptococcus and is characterized by a tendency to extend with an advance red border, by an intoxication fever, and by resolution through self limitation.

**Lesion.** The cause is streptococcus erysipelatis (Fehleisen). This bacterium gets into the lymph channels of the skin, usually upon the cheek, neck or in the vicinity of an operation wound, and not infrequently into the lymph channels of the underlying subcutaneous cellular tissue.

**Symptoms.** There first appears a diffuse blush that soon becomes red, with a well-marked cord-like redder border or advance line. This area is slightly raised from the surrounding skin, is of boardy hardness and is of neuralgic tenderness, especially on pressure. As the area enlarges the center is apt to pale and get white and scale. Blebs may form especially on the ear. These blebs remain clear, or

become purulent. They dry and scale, or if purulent may heal by granulation. Occasionally single small or multiple abscesses or rarely gangrene occur, but these complications are usually the result of a mixed infection. There is not infrequently an involvement of mucous membrane, causing conjunctivitis rhinitis and pharyngitis with its associated inflammation of the eustachian and middle ear abscess. The inflammation of the skin is the principal lesion. The involvement of it may be total, beginning upon the face in the well-known butterfly form, extending down the face and neck, and up over the scalp, and down the back, chest, upper and lower extremities by successive invasions or spurts. With each advance there is usually a recurrence of constitutional symptoms.

**Constitutional Symptoms.** The disease is ushered in by a well marked chill or rigor, rapid bounding pulse, and fever. The temperature at its height is 104°–105° and depends entirely and directly upon whether the disease is advancing or at a standstill. There is often severe headache or delirium, or exceptionally coma. The patients are not infrequently alcoholic. They may be maniacal or have a low, muttering delirium. There is marked prostration and usually albumenurea. Or all these symptoms may be of very mild type.

**Complications.** These are meningitis, rarely ; abscess, plegmon, pus joints, lymphadenitis, phlebitis, pneumonia, colitis, jaundice, nephritis, and rarely septicemia and pyemia.

**Diagnosis** is easily made. No other dermatitis is boardlike, red-edged and so painful, and gives such constitutional symptoms.

**Prognosis** is good as regards life. Patients practically never die in uncomplicated cases. But the length of time and extent of lesion is uncertain.

**Treatment.** Local treatment presumably serves its purpose but seemingly avails nothing. It should be antiseptic. Kraske's "bloody fence" seldom stops the advance of the "fire line". Internally the multiplicity of remedies avail as little. An abundance of whiskey, plenty of hot fluid diet and frequent salines are our best aids. The disease is self limiting in its own season.

## CELLULITIS.

**Cellulitis** is a suppurative inflammation of subcutaneous cellular tissue, whether septal, fascial, tendonous, or periosteal.

**Lesion.** The micro-organisms are the pus cocci and the bacillus of malignant edema. The lesions are either deep or superficial, circumscribed or diffuse, according to the location of the subcutaneous tissue involved. It is usually acute and varies from the slight cases that are circumscribed and superficial, of small area and of few symptoms, to these that are deep, diffuse and phlegmonous and cause sepsis and death. It may be primary, or secondary to other infection.

**Symptoms.** The *small superficial* cases give redness of varying quality, pain varying with the extent, whether of pea-size or two to three inches in circumference, the surfaces feel hot, and there is more or less hardness and swelling. There is much pain and functional disturbance, depending upon location near dense fascia or near a rich nerve supply. These cases may occasionally become deep and not infrequently diffuse, if neglected.

The *superficial diffuse* cases are red, or normal, or white, in color. There is much pain and functional disturbance, since they are apt as in the leg to involve all the superficial

cellular elements of the circumference of the part. They are at first hot and hard, but sooner or later begin to have points or areas of suppuration and fluctuation underneath the skin. This may strip the skin entirely from the underlying deep fascia and form one large tubular abscess cavity. Exceptionally the process is so toxic as to cause slough of the cellular tissue instead of suppuration and abscess. In these cases there are general constitution symptoms of sepsis, principally marked headache, nausea and general malaise.

*Circumscribed deep* cellulitis is comparatively seldom met with. It is very painful and soon becomes diffuse.

*Diffuse deep* cellulitis, or spreading cellulitis, rises often from a very trifling injury and may be ushered in with a chill. There may be no superficial redness, or the skin is edematous, boggy and mottled with dark red to blue red discolorations, or there are blebs with boardlike hardness, or the surface is white and doughy. The pain is at first marked and there is fever of 100° to 103°. Sometimes there are rapid sepsis with the formation of deep abscess, or gangrene ; or there is infiltration of the subfascia, tendons, sheaths and periosteum, pus pockets are formed, there are areas of softening. Not infrequently joints are involved and destroyed. Whole areas may slough or become emphysematous. There are metastatic abscesses formed, and pyemia results. Or there is marasmus, parenchymatous degeneration of the viscera, meningeal disturbances, or severe hemorrhage. With these worst cases there is delirium, lapsing into coma, high temperature and pulse ; all the symptoms of severe sepsis.

**Prognosis.** The disease is regularly progressive, suppurative and septic if untreated. From the mild to the very severe cases the prognosis depends entirely upon the kind, situation and treatment of the inflammation, and the constitution and courage of the patients.

**Treatment.** All cases need incision, curettement, drainage and the application of wet antiseptic dressings, either phenol or sublimate. Poulticing as ordinarily practiced is criminal. Dress the wounds two or three times daily. Clear up all new pus pockets, using drains of gauze or rubber tubing. In the superficial cases make inch-long incisions and depend upon rubber tubing for irrigation and drainage. In the worst and deep cases make long deep (Bellevue pus) incisions. As the exudate from these incisions ceases and the hemorrhage from the repair granulations appears, gradually remove drainage and use pressure to obliterate the deep pockets and hasten repair. If necessary place the parts in fixation splints, elevate and keep quiet. In the worst cases, when perseverance with the knife curet and drain have failed, amputate. But amputate high up and early. The constitutional symptoms are treated symptomatically with liberal use, when required, of the saline laxatives and the tonic alkaloids.

## SEPTICEMIA. PYEMIA.

**Septicemia** is a septic fever due to absorption of bacteria or their toxins and characterized by a chill, fever, rapid and feeble pulse, stupor, enteritis and albumenurea. It is generally fatal. A mild form of septicemia is familiarly called sepsis. If bacteria are present, it is possible to infect another patient ; if only toxins are present, it is non-inoculable. In the first instance the virulence of the disease increases with transmission ; in the second, the blood is non-infectious.

**Lesion.** The bacteria of septicemia are singly or in combination as follows: staphylococcus pyogenes aureus, albus and citreus, streptococcus pyogenes, micrococcus sep-

ticus, bacillus of spreading edema, the septic sputum bacillus, micrococcus tetragonus, three of the proteus group and others. The first four are the most important. The toxins are peptones, fibrin ferment, ferments, toxalbumens and cadaver alkaloids.

The bacteria enter at some local point and may afterward invade the general blood current causing acid, dark, thin blood of decreased coagulability and containing destroyed white and red blood cells. There is present small and large petechial submucous hemorrhages in the gastro-intestinal tract, similar changes in spleen and liver, parenchymatous nephritis and degenerative changes often in the diaphragm, heart and lungs. There is often a condition of general diffuse metastatic inflammation with infarcts and abscesses.

**Course.** This is very severe. In mild cases, such as absorption from large granulating surfaces following extensive burns, or such as rise from absorption from intestinal ulcers in typhoid, the course is fairly severe but may be ameliorated. Other cases are severe or grave from their very inception.

**Prognosis** of septicemia depends entirely upon the amount and type of the septic intoxication, and upon the possibility of early and complete clearance of the focal infection. The general condition of the patient and his response to stimulation is of next importance. It is pretty regularly fatal.

**Diagnosis.** The only fallibility possible is that of under-estimating the type of sepsis. In alcoholic patients this may be marked. It is to be differentiated from uremia, sapremia and pyemia.

**Treatment.** Clear the original focus of infection by operation, drainage and asepsis. Give alkaloidal and alcoholic stimulants, fluid diet and salines in abundance.

**Pyemia** is a septic infection due to infectious bacteria, and is characterized by the formation of multiple foci, or metastatic abscesses, and by an intermittent type of fever. It is pretty regularly fatal.

**Lesion.** There are principally two types of the disease. In one, there is a *large focus* of infection such as an infected compound fracture or suppurative inflammation of a joint. This gives us a continuous bacterial invasion, hectic fever, and death. In the other type, we have a *small focus*, originally in a small wound that has "healed", from which metastatic abscesses form, usually in the organs, causing a constitutional bacterial process and death. In both types septic thrombi are formed, especially in the lungs and spleen and also in the veins, heart, kidneys, joints, marrow, muscles, lymph nodes and brain.

**Symptoms.** The disease begins by a sharp invasion, a rigor following a chill, high rapid pulse, and a remittent or intermittent temperature depending upon the frequency of recurrence of new abscess formation. Otherwise the course is that of all septic fevers. If the course is at all chronic, exhaustion is a prominent symptom.

**Prognosis** is bad. Nearly all patients die in one to two weeks ; or in two to five months.

**Diagnosis.** It may be confounded with typhoid, malaria or acute tuberculosis.

**Treatment.** Asepsis of all abscesses and alcoholic, alkaloidal and fluid diatetic stimulation may avail somewhat. The use of antistreptococcus serum here as in septicemia has proven thus far to be of little use.

Closely allied to these septic wound fevers are a few of occasional occurence and minor importance, such as *cadaveric poisoning*, *cadaver tuberculosis* and *erysipeloid.* They are occupation sepses due to inoculation and to gross

negligence and uncleanliness. Their treatment is mainly prophylactic, such as the use of gloves, rubber gloves, vaseline and antiseptics. Upon injury and before full infection, the wound should be washed, freely sucked and treated with pure acetic acid. If they later become septic they should be incised early and a wet sublimate dressing applied.

## TETANUS, LOCK JAW, TRISMUS, THE LONG ISLAND DISEASE.

**Tetanus** is an infectious disease, caused by the spore-bearing bacillus of tetanus, and characterized by painful tonic and clonic spasms.

**Lesion.** The bacillus is clubbed and is obtained in pure culture with difficulty. The injury may be mild or severe. The germs enter at the point of injury and are found in the wound secretions, in the afferent nerve bundles and in the spinal cord. There is extravasation of blood in the spinal cord, proliferation of cells and granular infiltration of the nerve cells; all small in amount so as to be easily overlooked in postmortem. The disease is endemic in certain localities, in the ground soil and dust of the streets, so that any injury or slightest abrasion not treated antiseptically is subject to infection. The negro, being especially careless, is very frequently inoculated. He is very susceptible. The bulk of these cases report 3 to 10 days after the fourth of July, the injury, dirt and infection being acquired at that time. In certain places where the disease is endemic, vaccination and antitoxin treatment has to be carefully guarded, especially in the unwashed and ignorant. The incubation period is three to fifteen days.

At normal body temperature, the germ spores in 30 hours ; at 125° F, it spores in one hour. In dry pus the bacillus is virulent after 16 months. One percent of nitrate of silver kills the bacillus and spores in one minute.

**Symptoms** begin after an unimportant incubation period, usually from three to four days, with high fever and trismus. There is pain in the muscles of the face and neck ; the jaw and face muscles are set. The patient is anxious yet conscious, fears externals like noises, jars and air drafts, sweats profusely and has mild albumenurea. As the days pass he has clonic spasms more and more frequently, with intermediate tonic spasms of great intensity and causing severe pain. The head is drawn back, the corners of the mouth are drawn (the risus sardonicus), the legs have spasmodic cramps ; there is often opisthotonos ; the intercostals are often in spasm causing dyspnoea ; and there is occasionally total involvement of the diaphragm. Sometimes the muscles of the pharynx and esophagus are involved. Or only the upper extremity is uninvolved. The pulse is naturally very rapid and feeble, and the bodily waste excessive.

**Prognosis.** The acute cases live one to eight days. The chronic cases, with trismus only, live two to four weeks with or without recovery. About 80 to 90 percent of all cases are fatal. The shorter the incubation the greater the mortality.

**Diagnosis.** Differentiate strychnine poisoning and hydrophobia.

**Treatment.** Prophylaxis. Once acquired, give the patient a hypodermic of morphine, remove to a quiet, dark room and plug his ears. Give him fluid diet and chloral by stomach tube or per rectum and repeat the hypodermic as needed. The tetanus antitoxin has given but fair results. It has great possibilities.

## ANTHRAX, MALIGNANT PUSTULE.

**Anthrax** is an acute infectious disease, due to a specific bacillus, that is fatal to cattle and communicable to man. The bacillus of anthrax is aerobic, rapidly liquifies gelatine, forms spores in 24 hours, is influenced by antiseptics, is incapable of spore formation when treated with potassium bichromate, and takes on involution forms when the media are exhausted. It is attenuated by 110° constant temperature and produces immunity if inoculated then or if developed in media containing fibrinogen or bacillus pyocyaneus.

**Lesion.** In rag pickers or care takers of cattle it occurs *internally* as an acute anthracis of the lungs, or pneumonia, from inhalation; or from ingestion, there is a sudden onset, diarrhea and collapse, or septic (typhoid) symptoms and death: or *externally* it begins as an itching red nodule with a blue bleb, indurated and edematous, involving the lymphatics in 48 to 60 hours, giving constitutional symptoms and causing death from collapse.

**Diagnosis** is made from the occupation, and from the development of the case.

**Prognosis.** The internal form is regular fatal.

**Treatment.** Excise the malignant pustule widely and treat with antiseptics heroically. Kill all cattle and cremate them. If it is necessary to bury them, fence off the burial places widely for ten years.

The disease in cattle is of apoplectiform type and is acute or subacute. It was originally of Russian importation. The so-called anthrax antitoxin has given good service in the treatment of animals and has been used tentatively in man.

## GLANDERS, FARCY.

**Glanders** is an infectious disease of the horse, ass and mule due to the glanders bacillus, and is communicable to man.

The **Lesion** is characterized by a peculiar swelling of the lymph modes forming nodules in the skin and mucous membrane of the respiratory tract. These nodules break down and form ulcers and abscesses. There are secondary metastatic abscesses in the spleen, liver, kidney, testicle, bones and joints. The acute cases extend over 6 to 12 days; while the chronic forms last for years. In man there is sero-purulent catarrh of the eyes, nose and bronchi and the face and hands become inflamed and ulcerate.

**Symptoms.** The symptoms may follow a septic type, which early is scarcely to be differentiated from typhoid, with fetid muco-purulent discharges from the nasal ulcers. Or it may follow an arthritic type and give all the symptoms of a pyemia. A chronic form begins as ozena, is insidious, may go on to formation of ulcers and abscesses, runs a course of months and years, and may recover.

**Treatment** is wholly prophylactic, antiseptic and surgical.

## ACTINOMYCOSIS, RAY FUNGUS.

**Actinomycosis** is a progressive and suppurative inflammation, usually chronic, due to actinomyces in swine and cattle, and transmissible to man.

**Lesion.** The fungus grows in clubs, filaments, or in spore form. The clubs are arranged in stellate masses or

rosettes and are yellow. It is grown on plants and has a preference to grains of corn. In man it enters the system by the mouth and causes the jaw and gland cases; or the lungs, causing metastatic inflammation and abscess; or the intestine; or the skin following injury; or has unascertained entrance. In all cases the reaction to its presence is inflammatory and of a purulent or phlegmonous type, or granular or indurated, or pyemic with multiple abscess. In cattle it constitutes the lump jaw of cattle, which breaks down and discharges pus containing the characteristic yellow rosettes.

**Diagnosis** is made by means of the bright yellow granules.

**Prognosis** is dependent upon the lesion and the possibility of surgical interference.

**Treatment** is purely surgical. The nodules or abscesses are to be freely incised and thoroughly curetted. The rest is asepsis.

## HYDROPHOBIA, RABIES.

**Hydrophobia** is an acute infectious disease of the central nervous system characterized by a long and variable incubation period. It is specifically a disease of the dog fox and wolf and is communicated to man by inoculation. Its incubation period varies from fourteen days to six months and a year. The peculiar virus is strengthened by transmission through rabbits and weakened by dry heat. It is cultivated in mucus and broths. It behaves like a globulin and is probably an enzyme. If it is a bacterium it occurs in such small numbers as not to be recognized. Its action simulates tetanus, and is destroyed by metabolic products similar to strychnine.

**Occurrence.** In man 90 percent of the cases result from dog bite, 4 percent from cats, 4 percent wolves, 2 percent foxes. Of the persons bitten 15 to 50 percent acquire the disease. The disease is regularly fatal. It especially occurs in children.

**Lesion.** The bite at the time of the invasion is red and citatrized, or is simply burning or itching. On postmortem there is found an acute myelitis, hypertrophy of the axis cylinders and atrophy of the nerve cells.

**Symptoms.** After an incubation period varying usually from 18 to 60 days the patient gets restless and irritable and has loss of appetite. After a day's restlessness and suspicion, there occurs spasm of the pharynx larynx and the respiration. This causes salivation, suffocation, rapid high-pitched pulse and temperature of 101° to 104°. Concurrently there is reflex general clonic spasms (sometimes tonic), and perversions of taste and smell, and dread. In from one to three days the patient becomes exhausted and dies in a few hours from general convulsions, or quietly, or in clonic spasms. Consciousness is unclouded throughout.

**Diagnosis.** The patient gives a history of bite by a dog that is mad or supposedly mad. Get the dog and confine him. He will die in 3 to 8 days if he has rabies. Differential diagnosis is to be made from tetanus, strychnine poisoning and from simulated rabies.

**Prognosis** is regularly fatal without Pasteur treatment.

**Treatment** consists in inoculating the patient first with emulsion of the cord of a dog that has died of rabies, that has been dried 14 days and is rendered almost innocuous. The inoculation on the second day is with emulsion of 13 days' drying and so on to the tenth day. Then the patient has his last inoculation with an emulsion of 5 days' drying. This emulsion immunizes him completely from any invasion of the disease; it also harmlessly immunizes a

person not inoculated at the time of the dog bite. Pasteur has also a method of preventive inoculation. These methods save all but ½ to 2 percent of all cases.

Dog bites should never be cauterized. They are best treated by washing out well with warm water; then apply strong acetic acid, and dress antiseptically.

A rabid dog should never be shot nor otherwise disposed of, but confined, that his condition may be surely determined. This helps materially in clearing up pseudo-rabies.

About 80 percent of dogs are attacked with *raging rabbies*. They have a stage of irritation and suspicion lasting from ½ to 3 days, succeeding to one of mania lasting 3 to 4 days. It is at this period that the dog runs "mad" in straight uncertain directions, frothing, blind, snapping at everything with which he comes in contact, and changing direction only when he collides with some object, or wearies of his course. This stage changes to one of paralysis, especially of the hind quarters, in which the dog half stands bristling and unkempt with glazed and reddened eyes. He suffers from spasms, has dyspnea and dies in 3, 4, 5, or 6, days of exhaustion. In *still rabies*, 15 to 20 percent of all cases, the dogs have only the stages of irritation and of paralysis, and die of emaciation and paralysis on the second to fourth day.

## BITES AND POISONS.

**Insect Bites and Stings.**—We have in our latitude the bites and stings of several insects to contend with.

They usually excrete an acid that produces itching, burning, some redness, and the formation of wheals about the wound. The stings of the bee, bumble-bee, wasp and hornet are familiar. They cause a considerable swelling and some flushing that lasts for days, much pain of an itching, burning and aching sort, and the general symptoms of headache, weariness and prostration. Upon the face where there is a rich lymphatic supply there is marked swelling so that the features are mask-like. If there are many stings or entrance of the poison directly into vein or lymphatic, the skin frequently is blanched, there is marked prostration, cold clammy sweat, nausea, pulse small weak and dicrotic, sometimes coma. The patient may remain in this state of collapse for days and then recover; or there may be early collapse and death following the attack of a swarm or nest of the insects. Children particularly are severely affected. The treatment is application of compresses of dilute alkalies such as ammonia and saleratus and stimulation by alcohol and strychnine. The sting is found in the wound.

Spider-bites are a household legend. We have no formidable spiders native here. The tartantula is imported in bunches of bananas and not infrequently stings the handlers of these fruits, such as wholesale fruitiers, grocers and hotel cooks. Rather closely allied is the scorpion that is brought in similarly. They cause bad collapse. The patients are frequently alcoholic and respond badly to stimulation. The local treatment is antiseptic and alkaline.

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The bites of gnats and mosquitoes are familiar; they are best treated and avoided by the use of varying combinations of the essential oils. The mosquito proof house seems to be a permanent feature of malarial districts.

The bites of the flea, human and canine, of the bed-bug, of body, head and pubic lice, and the hen louse, are more or less familiar. The flea is familiarly the occupant of uphol-

stered street cars and railway cars in summer and is a permanent house tenant in the heavy rugs of our Russian tenement house population. It inhabits cushions and rugs where dogs are house-kept. The bed-bug is a concommittant of boarding houses and inhabits cracks and crevices especially in the quarters of our immigrant servants. The sand fleas, "red spiders," and jiggers live in sand wastes and sedge and mainly cause trouble by burrowing. They frequently require to be dug out. The bite of the flea and bed-bug is marked by a small central red point usually surrounded by a hard red base. The mark and irritation of the sand flea is larger, much reddened, often suppurating, and leaves behind bronzing of the skin. The human lice mainly inhabit the unclean, and closets used by the public. Sublimate solution kills them, and strong vinegar or dilute acetic acid dissolve their eggs from the hair. Hen lice are largely gotten from infested return crates while lounging upon railway platforms during summer outings. Bathing and sublimate rid them.

**Snake Bites.** The only native snakes that have poisonous bites are the rattlesnake or rattler and the copperhead or moccasin. They inhabit rocky mountainous districts and are seldom to be found in grass. They lie out upon warm stones in the sun and live in crevices. The rattlesnake in biting, coils, rattles, throws himself forward half his length and strikes. He is peaceable unless disturbed. The moccasin is silent in striking. The poison is contained in two sacks that feed the two hollow upper fangs. There is at most but a small drop or two of the poison. The bite is marked by the two indentations surrounded by a painful area that later may become anesthetic. This area, of varying extent and form, is mottled red and yellow by the blood coagulation and thrombosis that follow the bite. There are general symptoms of anxiety, nausea, vomiting, pros-

tration and often collapse. The treatment is immediately to suck out the wound in combination, or not, with incision or excision. The after treatment is antiseptics, quiet, alcohol and the tonic alkaloids.

**Indian Arrow Poison** is the product of putrifactive bacteria and should be treated accordingly.

## GONORRHEA. CHANCROID.

**Gonorrhea** is an acute inflammation of the genital tract due to the gonococcus of Neisser and is transmitted by sexual intercourse. It is by no means uncommon. Otis used to say that 500 out of every 1,000 married men in New York city had or had had gonorrhea.

**Lesion.** The germ is a large diplococcus and is seen in groups of six to thirty in a gelatinous envelope. On being placed on a mucous surface, especially if it be composed of cylindrical epithelia, the gonococcus at once invades the mucous membrane. The germ is in the lymph cells and epithelial cells as well as outside them; and is frequently associated with infectious pus germs and not infrequently with coli communis. The incubation period is 2-10 days. There is set up an acute catarrhal anterior urethritis, which tends to extend backward into the bulbous urethra and to become purulent. The germ readily infects the membranes of the nose, eye, rectum and vagina.

**Complications** are all too frequent. They occur in cases that are of malignant type, in mixed infection, in the chronic alcoholic, in home treatment cases, or where the remedy was "just as good" as another. They occur especially in irritation such as follows cohabitation or masturba-

tion during the last stages of gleet. The principal ones are as follows: Gonorrheal ophthalmia, following manual infection through uncleanliness. Prostratitis and cowperitis due to infection and occlusion of the cryptic folicles. Cystitis, from infection of the neck of the bladder and extension. Follicular and periurethral abscess, by occlusion of the secretory follicles near the bulbous urethra. Bubo, or septic infection of the superficial inguinal glands. Abscess, following bubo. Epididymitis, with or without occlusion of the secretory canals, and concurrent sterility. These complications frequently follow too early cohabitation, passing of sounds, and attempts at abortive treatment of the gonorrhea. Pyelitis, with or without cystic degeneration of the kidney, is caused by extension up the ureters. Gonorrheal arthritis occurs in septic cases. Lymphangitis of the penis in certain septic conditions is a comparatively rare complication.

**Symptoms.** A *first* attack is usually so mild as to pass unnoticed. There is itching at the meatus, and back along the urethra, the mildest sensation of warmth on urinating, the appearance of a half drop of milky, gluey mucus in the anterior urethra when squeezed and pressed forward, and there is gumming together of the lips of the meatus especially on rising in the morning. This is all. The symptoms last a day or two days, the mucus remains a week, and the inflammation passes; it is self limiting.

A *typical* attack begins, on the second, third or fourth day after cohabitation, with slight itching and burning at the meatus and back along the urethra especially on urinating; there is a turbid sticky drop of mucus almost impossible to express to view. The following morning there is a drop or two of yellow pus at the meatus, or upon the clothing leaving its greenish stain; the lips of the meatus are swollen and red, and the acid urine burns. Later, the

glans outside the meatus becomes red, the flow of thick pus is abundant, there is scalding urine, and tenesmus and pain back along the urethra to the perineum. About the third day of the outset the prepuce and glans are swollen, angry and tender. The inflammation travels back, the urethra is cord-like and tender on pressure, the patient not infrequently avoids urinating in public places on account of the exquisite pain, the last urine is voided drop by drop and is often accompanied by blood and followed by perineal tenesmus of an hour's duration, the stream is narrow, twisted and often spasmodically interrupted. About the third night painful erections begin, due to the inflammation ; this pulls upon the already tender urethra, the penis is bent backward and the patient is awakened instantly (with chordee). Now there is temperature, malaise, loss of appetite, and reflex constipation. In ten to fourteen days the acute symptoms pass, the discharge becomes watery, there is some scalding, the swelling and redness and pain disappear ; and the disease is *subacute.*

*Chronic Gonorrhea*, or gleet, begins at the end of the sixth week. There is the slightest mucous or muco-purulent discharge, only a drop or less, appearing in the morning. There is a patch of dark red granulation to be found just back of a contracted meatus or in the deep urethra. There are pus threads in the urine.

**Diagnosis.** Most patients give a straight history. A patient may have a non-specific urethritis from a variety of causes and not have gonorrhea. Here we have the gonococcus. One person may be infected and another not at the same source of infection.

**Prognosis.** Curable in one to three weeks if not tampered with.

**Treatment.** Rest in bed, light diet, no alcohol nor carminatives, an excess of fluid and acidulous drinks.

Cleanliness. Use of gonorrheal apron. For scalding, potassium acetate. For chordee, light bedding and combinations of morphine, hyoscine and bromides. As a urinary antiseptic and sedative, salol and oil of sandal. As a curative, permanganate irrigation from the outset, followed later by protargol injection, and in the chronic stage direct application of 20 grain nitrate to the granulations. Finally in the stage of chronic congestion stop all treatment.

The disease in the female is less severe. It is said to be primarily on the vulvo-vaginal mucous membrane and to be confined there. The urethra is infected in one-fifth the cases. There is frequent involvement of Bartolini's glands, which usually suppurate. Not infrequently the inflammation extends to the uterus and fallopian tubes, the ovaries and the peritoneum. In the simple cases the vulvæ are red and swollen and exude acrid pus, the urine burns, and there is a sense of discomfort and bearing down. Late, when the case is subacute or chronic, the cases are not to be diagnosed from leucorrhea, and are only suspicious. Treatment is sitzbaths, rest in bed, alkalies, salines, fluid diet, and as soon as possible vaginal boric irrigation. The chronic forms require swabbing with iodine and tamponading with glycerotannin.

The gonococcus may remain in the lacunae crypts and glands of the mucous membrane, especially of the male, and infect after twenty years, or autoinfect.

**Chancroid** is a local infection transmitted by sexual intercourse, due to a specific virus, and is characterized by ulcer, local metastatic gland enlargement and often abscess.

The specific virus is probably the strepto-bacillus of Ducrez. There are no constitutional symptoms. The infection occurs alone, or in association with gonorrhea or syphilis, or both.

**Lesion.** After an incubation period of two, to three, to seven days there appears on the penis, on its corona or prepuce or in the sulcus or on the frenum, one or more small red points or papules. This papule may become a vesicle or pass directly within one to two days into a pustule. This is surrounded by an area of hyperemia, the areola. On the second to fourth day the pustule breaks and forms an ulcer, which has a bright red rim that shades off into sound tissue, and whose base is reddish yellow with granulations that exude sero-pus containing fibrin flecks. This base soon becomes grey from slough, and exudes pus. The rim edges become less sharply cut and soon shade off into surrounding tissue. The ulcer is sometimes sharp-cut, but it soon becomes broad and irregular. It is very tender to touch ; is soft on the glans, and often hard and indurated on the prepuce. This process is about a week's duration.

Pathologically, there is no sclerosis of tissue. The leucocytes are in large numbers in the granulations and lie free in the connective tissue, which they break down. They are large and turbid and by invading neighboring tissue keep up a progressive destruction.

The chancroid may be simple or multiple or apposite. The pus from one chancroid is autoinoculable through any abrasion of the skin or mucous membrane in the same patient or upon another. The pus from the second chancroid is autoinoculable and so on almost indefinitely, but each lesion is of less virulent type. There is however no immunity conferred, since pus from the original source or from a new source will produce all the severity of the original infection,

**Varieties.** The lesion may be *simple* as described ; or it may be multiple, and because of the pus being confined within a tight prepuce a *sloughing* type is produced. In this, the whole sulcus and inner side of the prepuce is one large ulcer, the tissues are swollen and edematous, the outer skin becomes red and the whole penis is swollen. If uncared for, the prepuce sloughs through and the glans protrudes. Or a mixed infection takes place and the sore becomes *phagedenic.* Here, there is a slow destructive process of extension and erosion so that prepuce glans, and in fact the whole end of the penis is destroyed.

**Complication.** Formation of bubo. The glands of the groin, in cases of uncleanly or untidy habit, become infected by metastasis. The glands, one or more, may be only slightly swollen, be slightly painful in walking or on pressure, and will soon repair by resolution and absorption. Or the infection is severe. The inguinal glands become enlarged, swollen and tender. There are several glands involved but so agglutinated as not to be differentiated. There may be overlying redness and swelling, periadenitis, and decided fluctuation. The overlying tissue is septic, but only the suppurating glands contain the specific poison that is autoinoculable.

**Symptoms.** The secretions cause burning and itching. There is pain on pressure, and if the lesion becomes at all extensive the irritation is almost intolerable.

**Diagnosis.** This infection is not to be mistaken for anything else. It is autoinoculable on skin or mucous membrane. It is however to be differentiated from herpes preputialis and from the initial lesion of syphilis.

**Prognosis.** Always good save in alcoholics and the careless.

**Treatment.** The best treatment constitutes strict cleanliness, boric and sublimate scrubbing, dusting with

aromatic iodoform and the application of small pads of sterile gauze. Otherwise, the dusting with calomel, and the application of 20 grain silver nitrate or phenol or nitric acid is of use. Incise the buboes as they occur, cure them by treating them antiseptically.

In the female the chancroids are found just at the entrance of the vagina usually on the inner border of the nymphae. These are irritated and swollen and cause edema of the loose connective tissue there. They are to be treated as in the male, and pads of gauze applied to prevent infection of the opposing surfaces.

## SYPHILIS.

**Syphilis** is a chronic infectious and inoculable disease, probably due to the syphilis bacillus, and is characterized by the formation of chancre, copper colored rash, mucous patch, and gummata. The disease is generally acquired in sexual intercourse and is also hereditary, or transmitted in utero. One infection usually immunizes from fresh virus.

Syphilis has an incubation period of two to four weeks. Then follows the *primary stage* characterized by the formation of the initial lesion, the hard chancre. After a period of six to eight weeks, 12 to 130 to 159 days, succeeds the *secondary stage* characterized by the eruption of constitutional manifestations; the copper colored rash, sore throat, headache, the mucous patch and general lymphatic enlargement. After a variable period of six to twelve months the *tertiary stage* appears, characterized by gummatous tumors, loss of

substance in the bones, viscera, joints, muscles and skin, and sclerosis of the brain and spinal cord. Some authors include a quarternary stage, constituting syphilitic atrophy and marasmus.

The disease is transferred by coitus, kissing, cigars, drinking vessels, by instruments and operation, by and to physicians, midwives, nurses, dentists and barbers. Inherited syphilis is passed into the foetal circulation as tissue products and not as the specific virus. If the syphilis is fresh the foetus dies in utero ; if the disease is in the form of late syphilis it becomes congenital in the foetus, and is inherited syphilis.

**Lesion.** The syphilis bacillus of Lustgarten has not been made definite. Apes have been inoculated and a disease similar to syphilis or tuberculosis produced. It has been impossible as yet to cultivate and inoculate the virus successfully.

The chancre appears either as an indurated indolent nodule that degenerates and ulcerates, or as a papulo-vesicle that ulcerates and then indurates. It is always single and is usually placed upon the corona or frenum, or within the meatus in the male ; at the fourchet or variously in the female. Microscopically, there is an increase in round cells, some epithelioid cells, and occasional giant cells. The blood vessels are sclerotic and it is they that cause the induration. The repair of the chancre is by slow cicatrization.

**Symptoms.** The constitutional symptoms are probably caused by the virus products ; they constitute a luetic toxemia.

*Primary Stage.* The indurated nodule developes into the chancre, with broad hard indurated base, at the point of inoculation whether genital or extra-genital. The hardness is almost that of cartilage. The chancre is about pea-size or larger, its base is moist and opalescent and the secre-

tion little and clear. The chancre remains one or two months giving no special inconvenience and heals by cicatrization leaving usually a well marked life-long scar. There is an associated glandular enlargement of the near-by lymph nodes beginning a week or two after the formation of chancre and caused either by the virulence of the chancre-growth, or by a mixed purulent infection, or both. These glands become enlarged and hard, are freely movable under the skin, are painless and do not suppurate. This engorgement may be unilateral. The swelling subsides or runs on into the secondary stage.

*Secondary Stage*, or stage of constitutional symptoms. This may be ushered in by fever of 101° to 103°, or higher, depending upon the amount of general disturbance. There is headache, general malaise, back or joint pains worse at night, sore throat, loss of hair, and general involvement of the cervical postcervical axillary mammary epitrochlear inguinal femoral and popliteal lymph nodes. At this time, or before or after, there appears upon the skin of the abdomen an eruption that extends to the chest, shoulders, arms and neck, forearms legs and face, in successive weeks. This eruption is usually macular,—or papular, pustular, tubercular or squamous,—is symetrical, and of a peculiar copper-colored hue. Mucous patches, white blocked up blotches, appear upon the tongue, soft and hard palate or pharyngeal wall. These are infectious, as is the blood serum in this stage. The normal secretions such as urine, tears, and sweat are not. The fever is high or low, and undergoes exascerbations, according to the malignancy and development of these varying conditions. Rupia or blebs, tubercular and gummatous inflammation of the skin, are of infrequent development now except in malignant cases. The coppery rash, without pain or itching, and the glandular enlargement are almost pathognomonic of this stage.

*The Tertiary Stage*, or stage of gummata and destructive inflammations with loss of substance of tissues, is marked by late syphilides, gummata in the bone, skin, nose, brain and viscera, amyloid degeneration in muscle and viscera, and sclerosis of the brain and spinal cord. The gumma of bone sets up a destructive osteitis. The sternum tibia, ribs and cranium especially undergo marked inflammation and erosion. They are especially tender on pressure, and ache violently toward night causing the characteristic night-pains of the disease. Gumma of the brain will cause its varying symptoms of irritation or pressure. Gumma of the nose causes the characteristic syphilitic nose by destruction of cartilage, mucous membrane and bone. Viscera, glands, skin, joints, and muscle become gummatous and degenerate, or undergo amyloid degeneration or cloudy swelling, and give their various symptoms. There is frequently a peripheral neuritis of slow degenerative type. There may be iritis, or irido-choroiditis or syphilitic optic neuritis. There is dactylitis. Sclerotic changes in Goll's column of the spinal cord cause locomotor ataxia ; sclerosis of the cortex of the brain results in general paresis or paretic dementia. Syphilis not infrequently produces atheromatous changes in the arteries, especially the middle cerebral so that an apoplexy in early adult life is pathognomonic of syphilis. This stage lasts four to six months. It may appear as late as two years, or it may remain latent and erupt as late as twenty years.

The stages may be distinct or overlap, or be irregular or intermittent. The disease is inoculable into the third stage.

**Diagnosis** is to be made between chancre and chancroid. No positive diagnosis is possible, except by establishing non-inoculability of chancre, until the appearance of the copper rash and general lymphatic enlargement. This does no harm to the patient, and yet it is hard to make the

patient acquiesce in. It is an absolutely vital consideration.

**Prognosis** is good if the patient follows directions and medication intelligently. There is of course immediately raised the question of marriage. No syphilitic patient should be allowed to marry until he has faithfully carried out treatment for three years, till he has interrupted treatment for a year thereafter without occurrence or recurrence of a symptom, and shall then continue medication for a half to one year longer. Then and then only is he allowed to marry.

**Treatment.** No treatment of the chancre save cleanliness and none of the secondary symptoms until well developed. One of two methods is then to be chosen. Give the protoiodide of mercury gr. $\frac{1}{6}$ to its full physiological doseage as indicated by stomachal and intestinal tolerance. Or, rub in daily, pea-size masses of mercurial ointment over alternate lymph node spaces. Also support and stimulate the patient. After the constitutional symptoms have passed, the mercurials are to be used only occasionally or alternately with the tertiary stage treatment. Here, full doses of potassium iodide are given in large quantities of fluids, preferably milk. In cerebral tumor of syphilitic origin as much as an ounce of the iodide per day is frequently tolerated. After pushing the dosage of the drug for a few months, it is to be dropped back to moderate dosage and maintained for years.

**Hereditary** Syphilis is to be diagnosed by the scanty hair, drawn and almost scarred appearance of the skin, high-pitched and cracked voice, Murchison's teeth, the malnutrition, and the worn-out and generally-old expression of the child. Either one, or other, or both parents give the history of syphilis. Treatment is the alternation of mercury and the

iodide, or their combination in the well-known "mixed treatment." Added attention is to be paid to skin eruptions, alopecia, iritis, deafness, and the malnutrition.

## LEPROSY.

**Leprosy** is a chronic infectious disease due to the bacillus leprae and characterized by more or less circumscribed anatomical growths of the skin and nerves. The disease is not always infectious nor carried regularly by contact. It has not been of especial value to segregate the leper in colonies. The disease is congenital or hereditary or is acquired by coitus.

**Lesion.** The bacillus is found in the skin, nerves, spleen, liver and testicle and especially in the lymph glands. It is found in lepra cells,—large mononuclear cells or leucocytes,—in spindle shaped granular cells and in giant cells. It is cultivated and inoculated with difficulty. The skin nodules are made up of lepra, spindle and giant cells. The nerves either in their trunks or centrally undergo an obliterating sclerosis and descending degeneration, and anaesthesia results. The incubation period is one to two to five years.

**Course and Symptoms.** In the *skin* there is hyperemia, then pigmentation, then granular nodes are formed. These nodes are small and pea-size, or large and form irregular tuberculous masses. The nodes are upon the face, hands, feet, knee and elbow. They tend to degenerate and form ulcers at one point while they extend at another. There may be gangrene and mutilation of the extremities.

In the *anesthetic* type there is at first hyperesthesia and pain, then anesthesia, and finally trophic changes, according to the progress of the neuritis. There is often distinct evidence of white or brown areas that are anesthetic. Finally there is atrophy of bone and muscle and mutilations. As a sequence of the interstitial sclerosis of the nerve tracts there may result late an ascending neuritis.

There are also *mixed* types of the disease.

**Diagnosis.** The nodular type is to be differentiated from syphilis, the anesthetic from syringomyelia.

**Prognosis** bad. The anesthetic type continues for fifteen to twenty years, the nodular for five to ten years. There are few if any cures. The patient usually dies from exhaustion or some intercurrent disease.

**Treatment** is almost wholly hygienic. The ulcers are cared for aseptically. The patients are maintained in isolation colonies, as at Molokai in the Hawaiian Islands, or as in the Scandinavian settlement in the north-west. In New York City there are a considerable number of lepers registered and kept under surveillance, but allowed to go at large. Nerve-stretching has been advocated and tried but has lost favor. The antitoxin treatment is not yet successful.

## TUBERCULOSIS.

**Tuberculosis** is a chronic infectious disease due to the tubercle bacillus and characterized by the formation of the miliary tubercle. Tuberculosis seems to have a particular predisposition to attack man. It is prevalent among all nations and in all latitudes and climates. On our own conti-

nent it is decimating the Indian, Esquimo and negro, and especially their race hybrids. In our civil population about one death in six is due directly or indirectly to tuberculosis, and about one-third of infant mortality is due to the same cause. The disease is not hereditary and not contagious in the accepted sense of these terms. It is directly infectious from parent to offspring by contact, and from person to person by contact or through the medium of the air. The germs are carried by dried tubercular sputum or discharges to be inhaled or ingested or inoculated. The disease has its particular nidus in the lungs and may lie there latent for years until some irritation causes it to be active and to multiply. All other tissues and organs of the body are capable of invasion by it, but to a much lesser degree and more insidiously. The disease is common in all domestic animals, but has not the same highly differentiated bacillus and toxic toxomucin. The bovine and the human viruses are probably not trans-inoculable. There is claimed an hereditary predisposition of a tubercular character but this is probably not tenable. The disease is transferable through the medium of the air, dust, flies, or by vehicles of common carriage, by door-knobs, or in fact in any habit of of life through uncleanliness. It may be inoculated by cuts and abrasions into the lungs, circulation, glands, bone and marrow, and there become a local lesion ; it afterward may become general, *i. e.*, a disease. The tubercle bacillus is especially thick walled, as typhoid, and contains within this wall its own peculiar toxin. The germ is an aërobic, is capable of withstanding considerable changes of temperature and environment, but is soon destroyed by sunlight.

**Lesion.** The bacillus having gained entrance into a tissue, there is begun the formation of a miliary tubercle. There is hyperemia and proliferation of the fixed connective tissue cells. From these embryonic cells, epitheloid cells

are formed, and either by coalition of the connective tissue cells or more probably by karyokenesis large multinucleated giant cells are generated. These small round, large epitheloid and giant cells with the multiplied bacilli scattered in and among the cells constitute the tubercle. The cells in a short time wall off the blood vessels from their mass and the tubercle with its enclosed bacteria becomes latent. Then one of several things may happen. The tubercle undergoes typically a cheesy or fatty degeneration and becomes a caseous nodule. This is due in part to the lack of blood supply and in part to the toxomucin generated by the bacillus. Or they undergo coagulation necrosis and form homogeneous masses. Or they become infiltrated with lime salts and form concretions. Or there is mixed (pus) infection, and the nodules break down and ulcerate. The typical death is by caseation. The tubercular inflammation is caused by the bacillus, the death of surrounding tissues by the toxin. The typical tubercle is the grey or pinkish miliary nodule of millet-seed size.

**Extension** of the tubercular inflammation is brought about by means of the wander cells. They carry the multiplied and freed bacillus to new tissues, there to form new individual foci or to coalesce and form masses. One outbreak always forebodes another. No tissue is free from its attack.

In the skin and subcutaneous tissue it exists as tubercular nodules or as lupus.

It is rare, primarily, in muscle and intermuscular and septal tissue.

As tubercular lymphatic gland enlargement it is familiarly but wrongly known as scrofula. These glands especially the anterior cervicals are continually breaking down to form abscesses and scars.

Tubercular meningitis is not uncommon in children and if acute is regularly fatal. If chronic it constitutes hydrocephalus.

Tuberculosis of the intestinal tract causes the bulk of the summer diarrhea in children in our cities and the large seasonal death rate. Marasmus is caused by tubercular mesenteric glandular enlargement. There is malnutrition, gradual wasting, starvation and death by chronic stages.

There is occasional involvement of the tongue, palate, pharynx, ear, lips, nose, breast and rectum, but there is often a coincident history of direct infection of these parts.

The bones and joints are very frequently infected through the blood supply, and local or general purulent and necrotic inflammations result.

The synovial membranes and synovial tendon sheaths are frequently involved, become purulent and ulcerate.

The peritoneum is not infrequently infiltrated with nodular growths of tubercular origin. If these coalesce, pressure tumors are formed.

The lungs per se is the home of the tubercle. Whether in the form of acute, subacute or chronic phthisis (apical), or as acute or chronic pulmonary tuberculosis (general), the disease causes about 10 percent of the total deaths from all causes.

Tubercle is not infrequent in the testicle bladder, kidney, spleen, liver and heart and there forms nodules and causes purulo-cystic degeneration.

**Prognosis** is bad. Early removal of the tubercle in surgical cases is of value. The disease once established is prone to break out anew.

**Diagnosis** is made by means of the history, by process of exclusion, and through experience. The presence of the bacillus and of the tubercle makes it certain. Suspect every patient; the bacillus is almost omnipresent.

**Treatment.** Prophylaxis is abetted by separating children from tubercular parents. No tubercular person should ever have the care of children. If it is impossible to disrupt families and isolate the tubercular, the people may yet be educated to better hygiene through the means of compulsory registration. By this moderately moral means the people, as in New York City, have had it brought forcibly to them as tubercular individuals that they can and must protect themselves and others by the use of hygienic sputum cups and the burning or sublimating of all tubercular excreta and dressings. Pulmonary tuberculosis is to be favored by good hygienic dress, food and surroundings, and by early and constant pulmonary and bodily gymnastics. Or the patient is sent to either a high and dry climate like Colorado, or the Rigi ; or to a dry and warm climate like Arizona ; or feeble patients are sent to a moist and warm climate like California, Florida, the Azores, or Egypt. Here they must live a quiet out-of-doors life and as quietly and constantly ingest large quantities of highly nutritious food abundant in fats. Surgical tuberculosis must be cleared up early and thoroughly. Iodoform, aromatized, is a good local dressing. Great care must be taken of the general constitution of the patient.

## WOUNDS.

**Wounds** are solutions in continuity of any tissue, usually the result of sudden traumatism. They comprise contusions, dislocations, fractures, and ruptures of blood vessels, nerves, viscera, muscle and skin. They result from accident and, depending upon the amount of damage done

to the tissues and the involvement of important structures, they are said to be mild or severe. If the wound occurs without skin break it is termed subcutaneous, otherwise it becomes an open wound. It is simple if it involves only soft parts ; compound, if there is access to wounded bone. It is clean or infected, aseptic or septic, depending upon absence or presence of septic bacteria. Open wounds are classified, corresponding to the instrument, as incised, lacerated, punctured, perforated and penetrating. Gun-shot wounds are a special class caused by the penetration of shot or bullets. By foreign body is meant the presence of extraneous matter in a wound.

**Lesion.** Broadly stated, wounds repair by primary or secondary healing or by aseptic blood clot. The pathology of wounds is that of inflammation.

*Primary healing* takes place in those wounds that are clean and capable of immediate closure ; or in those that once infected and granulating have been scraped, cleaned and closed.

Others that are septic, lacerated, or that have suffered a considerable loss of substance, must repair through a process of granulation and cicatrization ; by *secondary healing*.

A third class, not large, that have sustained a considerable loss of substance deep in the tissues, forming cavities, may occasionally be repaired by *aseptic blood clot*. A fresh cavity or an old granulating cavity, carefully scraped and cleaned, is under the strictest aseptic procedure allowed to fill with blood. The overlying structures are closed and repair takes place somewhat similarly to primary healing. The enclosed blood coagulates, not being infected, new blood vessels come off from the walls of the cavity and form a network throughout the clot-mass, connective tissue cells proliferate, the fibrin and cells of the clot are degenerated and are absorbed, the full repair taking place thereafter in

all respects like primary repair. The method is also known as organization of blood-clot. If infectious bacteria enter, suppuration takes place and the wound must repair by secondary healing.

Occasionally a condition of traumatic or surgical emphysema, or erodermectasia, is present. It is due to the presence of air under the skin, or gas formed by putrifactive or other changes there and causes crepitation on pressure.

**Symptoms** of a wound locally are, pain, hemorrhage, gaping and impairment of function. These depend on the amount and kind of tissue injury. The constitutional symptoms are varied and consist of collapse, syncope, shock, at times certain nervous manifestations such as hysteria, delirium or mania, anemia in great loss of blood, and various digestive, excretory and secretory functional disorders.

**Complications.** Wounds are complicated by the general infections, whether of sepsis, tetanus, erysipelas or cellulitis. The presence of organic disease of the viscera is a very vital one. Syphilis and tuberculosis delay or prevent repair. Hemophilia is a serious complication. In wounds involving bones, fat embolism and ferment poisoning interrupt repair or cause death. Intercurrent diseases such as pneumonia, nepritis, delirium tremens, traumatic delirium and apoplexy seriously or fatally complicate the wound repair.

**Prognosis** in uncomplicated cases is usually good.

**Diagnosis.** Two prominent symptoms, pain and functional disturbances, aid the surgeon. Unless the patient is unconscious he will always complain of and locate the painful point. If unconscious, palpation over the wound will bring out its location through reflex movements of the body. Loss of function at any point is suspicious, though not always diagnostic. In open wounds, hemorrhage immediately locates. The various symptoms are masked by opium,

alcoholism, shock, and certain other central nervous disorders, and are often interdited by syncope and collapse. In these conditions suspend diagnosis, make the patient comfortable and watch the sequence of events.

**Treatment.** Pain may be relieved by the use of local or general anesthetics, by opium, alcohol, anodynes and hydrotherapy, by closure of the wound, and by restoration of nerve trunks to normal function through relief from pressure, as in fracture and dislocation. Ligature all bleeding points and employ hot water flushings or iodoform to stop capillary oozing. Close open wounds by deep suture, with or without drainage, as necessity demands. And above all be clean.

Wounds may need cleaning. Remove the blood clot and foreign substances if there are any. Cut off any devitalized parts such as dead tissue, as in contused and lacerated wounds, but be sure that the parts are dead. It is often good procedure if there is any question of the vitality of a part to allow it to remain, but to provide means of drainage for subsequent sloughing. Save all tissue possible. Scissors and the curet are to be preferred to the knife, as less bleeding follows their use.

Sponges of cotton, or gauze, are of use to damp off oozing surfaces. The head mirror and small pea electric lamp are almost indispensible for use in cavities. Frequent irrigation or wringing of warm saline into the wound is serviceable to keep up vitality and clean the parts.

The instruments, hands of the operator, and all externals must be clean and must be kept clean, and primary healing results. If the wound is already infected; with careful asepsis and with the help of the normal alexins of the fresh blood, the wound may still heal primarily.

In infected, and especially in old infected and suppurating wounds, the free use of the curet and irrigations of sublimate 1-2000 may change the current of affairs. But

if infection persists, especially in pockets and deep cavities, open freely or pack with sublimate or iodoform gauze and provide efficient drainage and wet antiseptic dressings. These wounds undergo repair by granulation.

Gaping wounds are closed by coaptation sutures, muscle tendon and nerve ends are sutured, all dead spaces are obliterated by suture and pressure, and the skin edges are carefully apposed. An aseptic scab forms along the closure line and repair is had in primary healing in a week's time.

In repair by granulation when near the surface, the skin edges may be brought together by adhesive straps placed well back from the wound edges, thereby lessening the extent of scar and hastening repair. Not infrequently in granulation repair, by freshening the surface thoroughly and use of coaptation sutures or straps, wounds may be closed aseptically and undergo primary healing.

Care should be used to avoid too much tension in suturing as the skin becomes edematous and pressure results. This interrupts circulation, both in the skin and underlying tissues, and slough or stitch abscess results. Simple wounds, such as finger cuts, may be closed sufficiently well by application of the roller bandage. More extensive wounds may be closed by adhesive plaster straps, or dressings overlapped with collodion. In a wound at all extensive or bleeding the use of hair lip pins or sutures is indicated.

Drainage is the surgeon's hesitancy or his necessity. If all arteries are securely ligated, the capillary oozing stopped, the tissues sound and well coapted, there is no necessity for drainage. Subsequent hemorrhage or infection as indicated by wound fever may demand reopening of the wound, at least in part, and the establishing of drainage. Occasionally in deep tissues, such as thigh amputation, where perfect coaptation of the deeper parts is practically impossible, it is not infrequently the rule to insert small

drainage tubes to deep parts for a day or so, or to leave open a dependent part of the wound in order that the so-called wound excretions may escape. Some surgeons regularly provide counter-drainage. Others provide no drainage whatever but depend upon dressings, pressure and elevation.

The requisites for dressings are that they shall be clean and of a material such as shall absorb and not mat down and of a mesh sufficient to allow air and any wound secretions and other exudates to pass freely through. The material such as cheese cloth or open-meshed cotton gauze is the best. It is firm enough to aid in protecting the wound from motion and injury.

These dressings shall be changed because of hemorrhage, following closure of the wound, or because of temperature at the end of three or four days, indicating infection of the wound. Temperature of one to three degrees, a day following operation, and dropping to normal on the third or fourth is indicative of ferment intoxication or ordinary wound fever, and is not an indication for change of dressings. If, however, the temperature remains high on the fourth or fifth day or suddenly rises after it has previously fallen, with or without chill and hectic flush, there is sepsis ; the dressings must be removed and drainage established. Occasionally, however, such a temperature marks only an erysipelas of the wound, the deep tissues being sound. In this case removal of the dressings establishes the underlying condition. In rare cases, the sutures must all be removed and the wound treated by the open method of loose gauze packing.

The suture line of a wound is dusted with some fine hydroscopic and antiseptic powder, or is covered by thin rubber cloth or vamping, or silver or gold foil is matted over it, or absolutely nothing is applied.

Of the *constitutional symptoms*, pain is controlled by a single dose of an opiate. Further exhibition of the drug is avoided unless absolutely necessary to relieve sheer restlessness and to avoid damage to the injured part. It causes diminution of secretions, constipation and a dependence upon the drug and moral obliquity, but worst of all it masks pain upon which we depend quite as much as upon pulse and temperature to guard against marked exudation, and to estimate infection in the wound. A firm, cheerful and concise statement by the surgeon of the operative conditions gives the better results. There is much metaphysics in after-treatment of patients. Keep up strength by nutrition and stimulants. Lean upon salines, alcohol, warmth, sunshine and fresh air.

**After-treatment.** In primary healing there is no necessity for changing the primary dressings until the sixth, eighth or tenth day or longer. In case of soiling of the dressings from occupation, partial removal and renewal is all that is necessary. The second full dressing is made sufficently simple to protect the repaired wound from injury. Occasionally it is necessary to remove a primary dressing on the second to fourth day on account of stiffening from dried wound secretions. This must be done with strict precautions of cleanliness both in method and dressings. The same precautions are taken in removing a drainage tube upon the first or second day. Be over-careful and over-long in granting freedom to patients having extensive or major wounds. A few extra days in bed may save months and years of distress, since the tissues, though they have completed primary healing, have as yet not undergone a certain sort of scar-tissue formation and regeneration that is necessary to give them their old resiliency. Finally, the surgeon should be so sure of his findings, methods, procedure and

assistance as to make sure of absolute results of primary healing.

Foreign bodies of clean and not of corrosive material often encapsulate within a fibrous tissue membrane and remain permanently or for a considerable time innoxious. Should they subsequently produce pain or set up inflammation they are readily cut down upon and removed. Such foreign bodies as needles are allowed to remain unless easily obtainable, as they slip readily away and the surgeon may do more harm than the needle. Only when in the neighborhood of joints or important organs should they be seriously searched for. They may escape even under the most careful technique, and travel, to appear at a shorter or longer period at some distant surface point, there to cause a painful small raised surface marking and to be removed. Shot and bullets lie imbedded for years in the skin tissues or old healed sinus track and give no trouble ; or they irritate and cause painful or excruciating neuralgias. Pieces of clothing and gun wads carried into the body become immediately the cause of pus and pus sinuses and demand immediate removal. Splinters of glass and bits of glass are most often septic and if unlocated at the time of the first dressing soon manifest themselves by sharp stinging pain on pressure and after a few days, if not otherwise looked after, work their way into the wound or to the surface. Similarly spicules, prickers, thorns, and splinters are painful and septic, and if not removed are potent factors as causes of cellulitis and abscesses of virulent type.

# HEMORRHAGE. AIR EMBOLISM. SYNCOPE. COLLAPSE. ACUTE ANEMIA. INTERNAL HEMORRHAGE. SECONDARY HEMORRHAGE. HEMOPHILIA.

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**Hemorrhage** in an injury may be of the very mildest type or may cause immediate death. When mild, superficial and subcutaneous, it constitutes a simple *bruise*. The traumatism may simply cause exudate of blood elements into the tissues without any special injury to the capillaries, and result in almost immediate repair by absorption and endosmotic action. In this it corresponds to the edema of a wheal or welt that follows the stings of insects or the stinging blow of a whip. If the injury be more severe and the subcutaneous injury to the capillaries considerable, there is direct emptying of blood elements in small quantities into the superficial tissues, as in black eye. This injury or severe bruise, constitutes an *ecchymosis* or suggilation. The blood elements cause pain and especially considerable pain on pressure. They remain from three to four days or even one to two weeks, until repair of the blood vessels takes place, and gradually reabsorb, leaving behind until the pain and blood are quite gone mottling of yellow, green and brown markings. These markings are especially common in association with sprains, where the rich articular net-work gives way with the ligamentous structures. If, however, an artery or vein of considerable size is ruptured in loose connective tissue spaces, a *hematoma* or blood tumor is formed. These tumors are frequently very painful and of considerable size. They are very prone to infect and become abscesses, since they are usually superficial, the product of trauma and of necessity stagnant. They usu-

ally, if they remain aseptic, undergo anabolic repair. Or they become organized by the formation of new blood vessels through their mass and subsequent cicatricial repair takes place. Exceptionally these hematomata may become permanent, through patency with a vein, and constitute a blood cyst or tumor. Minor hematomata may strip up the epidermal layers of the skin and form blood blebs or blisters.

In open wounds, hemorrhage may be practically nil, due to the rupture of the intima of blood vessels and consequent thrombosis as in contused and lacerated wounds.

Arterial hemorrhage is bright red in color, and is mild or severe, depending upon the capacity and patency of the artery. If the arterial end is free in the wound there is spurting of blood from the wound in synchronism with the heart beat. If the torn vessel is buried the blood simply wells up in the wound. If the artery is torn or cut clean across and not of great caliber the contraction of the muscular coats causes total or partial occlusion of the lumen of the vessel. If the blood vessels are only partially torn, especially in longitudinal cuts of an artery, contractility not infrequently causes the arterial wound to gape wider and the blood flow to be increased.

Capillary hemorrhage is of bright red color and oozes or slowly wells up in the wound.

Venous hemorrhage is dark red in color, without pulsation, and is especially persistent in partial section of the vessel. It wells or floods up into the wound. Partially torn and ruptured veins, when of large caliber as venous trunks, do not totally collapse proximally, being held open by surrounding structures and may allow large quantities of air to gain entrance into the circulation—**air embolism**—with fatal results.

**Course and Symptoms.** Hemorrhage may be none, or small, or considerable, or severe, or fatal.

*Small* hemorrhage causes no symptoms save, perhaps, syncope on the part of the patient at sight of blood, and is controlled easily by external pressure such as bandaging.

In cases of *considerable* loss of blood the patient may faint rather from nervous reaction than loss of blood, or may be white or blue about the face and mouth, with accompanying large beads of cold sweat standing out upon the forehead at the hair border, or upon the sides of the face, on the ears and neck, under the eyes, or at the sulci of the lips.

The hemorrhage may be *moderately severe* and difficult to stop and may require ligature of the bleeding vessel, or section and ligature, or ligature en masse, or pressure by deep suture, or flushing of the wound surfaces with hot (114°) saline. There are as yet no constitutional symptoms caused by loss of blood unless the wound has been long uncared for and the bleeding constant, as in chopping accidents where the patient is alone, cannot contral the bleeding and faints from loss of blood. There is consequent relaxation of the tissues and increased hemorrhage, and the man may bleed to death before he is discovered. Occasionally there is spontaneous arrest of hemorrhage since the syncope causes a reduction in both the force and flow of the blood current.

*Severe* hemorrhage causes collapse and acute anemia on account of bulk of blood lost. It happens in large, clean-cut wounds involving large vessels. Or in **Internal hemorrhage** combined with shock, as in fracture of a rib and perforation either of an intercostal or a blood vessel at the base of the lung, or in cases of slipping of a ligature in abdominal operation, in intestinal hemorrhage, or in rupture of spleen or liver. Provided the hemorrhage is not too

abrupt, often two to three quarts of blood, approximately half the blood supply of an average man, may be lost. If, however, a large quantity as two quarts of blood is lost suddenly, there is immediate if not fatal collapse. The blood bulk is made up in two to three days by absorption of fluids from the digestive tract, or artificially by enemata or transfusion and hyperdermoclysis, and the patient recovers from the collapse. The patient remains asthenic, however, for days and weeks and only recovers his strength and color when the red blood corpuscles are reduplicated.

*Fatal* hemorrhage such as follows the erosion of a large pulmonary vein or the section of the femoral or carotid arteries and leads to the loss of quarts of blood in a minute or two, causes death with convulsive spasms of the whole body through irritation of the automatic centers in the medulla.

Clinically, hemorrhage is *primary* such as occurs immediately after injury ; or is *intermediary* such as occurs within one to two days from slipping a ligature or a thrombus, especially on movement of the wounded part ; or as **secondary hemorrhage** when occurring after the formation of a thrombus. This is due to atheroma, suppuration, erosion of vessel walls or too rapid absorption of the vessel-ligature.

**Treatment.** First, stop the flow of blood by direct compression over the bleeding point or by tourniquet applied to the proximal blood-vessel trunks. These methods should be cleanly so as to avoid septic infection and the subsequent formation of septic thrombosis. Children and old people bear loss of blood badly, though children repair quickly, and hemastasis must be carried out rapidly and fully. Stimulants of alcohol, strychnine and digitalin are to be given freely. After the patient has rallied, farther steps in the way of ligature suture and dressing of the wound may be undertaken.

Applications of continuous cold, or of intermittent heat are of use in the repair of subcutaneous hemorrhage. Cold contracts the arteries and maintains the tonicity of the blood vessels. Heat flushes the surface capillaries and by reaction contracts them. It also aids the formation of fibrin ferment and coagulation.

There may be a ferment intoxication fever, and general asthenic condition. There may be low muttering delirium. These require quiet and rest in bed. Opiates in small and repeated doses are given. The patient is thirsty and requires copious draughts of both hot and cold water. Hot water bags, well-wrapped to avoid burns upon the paralgesic skin, are used to give artificial warmth. Enemata of alcohol or hot normal saline are very useful to remedy the collapse. Fresh air, elevation of the foot of the bed, artificial ischemia by bandaging the extremities, and the administration of hot fluid diet all aid in establishing reaction. Care for the patient but above all keep the patient quiet. In severe prostration resort to hypodermoclysis.

Blood is rendered coagulable through the office of the ferment, thrombin, of the degenerated white blood cells and placques, and is augmented by an access of calcium salts in the blood. This is made use of by the ingestion of excess of phosphate of lime before an operation.

On the other hand the blood is rendered less coagulable by a diminution in nucleo-protein at any one time. and is also retarded by excess of sodium and magnesium sulphates. A condition of the blood, **hemophilia,** occurring in a class of patients known as bleeders, is of a similar nature. The condition seems to be an hereditary one and passes from grandmother to father to daughter, choosing so far as possible only female lines. Bleeding occurs from the slightest abrasion or injury. Fatal hemorrhage has followed tonsilectomy or the extraction of a tooth. This

bleeding also follows any instrumental attempts at ligation, suturing, cauterization and the like. The bleeding is best stopped by pressure, by the administration of chloride of calcium, or by the local application of powdered suprarenal extract. In certain cases the normal alexins from the blood serum of a healthy man have been of service.

**Syncope**, or fainting, is a condition due to irritation and inhibition of the vagus,—due to externals such as fright or worry or to certain nutrition losses, such as hemorrhage,—acting upon the inhibitory center in the medulla. The patient loses consciousness, or is subconscious ; the pulse slows, or is arrested. There are changes in the periodicity of the heart. The blood current slows and diminishes in volume. There are changes in the nutrition of the blood due both to the differences in balance in blood flow, and to stasis. Treatment is stimulants and horizontal posture. Quiet.

**Collapse** is extreme prostration and depression from failure of nerve force. It again is due to externals but more especially to nutrition losses. When fluids are withdrawn from the body the nerve centers are cut off from their full nutrient supply and collapse follows. Witness the effect of large doses of glonoin, of drastic cathartics such as calomel and jalap followed by epsom salts, of the copious watery discharges of diarrhea, dysentery and cholera, and compare severe loss of fluids by hemorrhage. Treatment, fluids, stimulants, warmth and quiet.

**Acute Anemia.** The blood constitutes about 7.7 percent of the bodily weight. A normal healthy man of 156 pounds has therefore about six quarts of blood in his body. This is normally distributed in approximately equal parts between the systemic circulation, the pulmonary circulation, the viscera, and the resting muscle. The abstraction of a large quantity of blood,—as two quarts, one-third the total,—from these various systems, tissues and organs, diminishes not only the blood bulk but causes slowing of the current, collapsed vessels and stasis in tissue and organ, and renders the red blood cells less efficient as oxygen carriers. Such a withdrawal of blood volume is not necessarily and immediately fatal, provided that the volume is repaired within 24 to 36 hours. The blood cells are reproduced only after days and weeks and even months. Their withdrawal seems to affect only a reduced anabolism and katabolism of the body and demands a lessened vigor on the part of the patient until the time of their upbuilding.

## SHOCK. TRAUMATIC DELIRIUM. DELIRIUM TREMENS. FAT EMBOLISM.

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**Shock** is a depression of the central nervous system, due to injury, operation or mental distress, causing disturbance in the control and sustainance of the bodily functions. Shock is of any grade. It may be so slight and disappear so rapidly that it is scarcely to be diagnosed. It may be so profound that the patient never rallies but gradually sinks away and quietly dies. Occasionally shock is marked by maniacal symptoms.

Alcoholics, users of opium, and those unused to sickness and suffering bear shock badly. Women are less susceptible to shock than are men. Those of exalted mental habit or high mental power are more susceptible. Lymphatic temperaments, as in our heavy athletes, resist it. The very young, from lack of nerve development, and the very old from nerve dullness are not prone to shock.

Shock is a condition of hours or a few days. The symptoms pass off and the patient rapidly recovers by reaction or dies immediately or gradually. Children suffer from shock but a few hours and rally quickly if at all.

Shock from injury, such as a badly mangled compound fracture, is marked from the very time of accident. Nearness to a vital or sensitive point or to the cerebral centers causes it to be more profound.

Shock from operation is of course masked by the anesthetic. It may cause immediate depression and death before completing the operation, or it may be continuous with the symptoms of narcosis and the patient reach his bed and rally only after full or even heroic stimulation.

Shock from mental distress is as varied as are the causes of the distress. Joy, grief, disasters, sudden surprises and frights, any sharply defined psychic disturbance may cause it. Shock in these conditions reacts sharply, or shades over into conditions of bodily collapse, general neurasthenia, or meningitis. Or it may cause death, suddenly or gradually.

**Lesion.** There is none postmortem.

In shock there is disturbance of the vasomotor centers in the medulla. These centers are altered, weakened or paralyzed, causing inhibition of the heart, depression of the circulation, anemia of the lungs, venous congestion and abnormal distribution of the blood.

**Symptoms** are those of general depression. There is general pallor, cold skin and blanched membranes. The face is pale, the lips blue, the eyes dull and lustreless, the pupils dilated. The heart's action is delayed, weak and irregular. The pulse is rapid and feeble, often thready or imperceptible. The respiration is shallow and irregular and may be prolonged and infrequent. The patient may seem simply syncopic, or he is found unconscious. Otherwise the patient is weak and apathetic and his mind is dull. He is mentally confused when questioned and his answers are incomplete or unsatisfactory. There is usually subnormal temperature. There is as a result of the muscular relaxation, no attempt at sustaining bodily position, there is nausea and vomiting and involuntary evacuations of the urine and feces. Or there is over-excitability, syncope and death.

In operation, the patient may die immediately upon the table or quietly in bed, with or without recovery from the anesthetic. The pulse grows more rapid, feeble and thready. The features become pinched and haggard. The face is cold and looks old. The patient is apathetic and lapses into unconsciousness. The temperature, if any previously, now goes to subnormal. The respiration becomes more shallow and weak, and finally respiration and the heart fail for want of oxygen. Upon postmortem the heart is found empty and contracted and the lungs collapsed and dark from congestion.

**Complications** of shock are hemorrhage, septic infection, fat embolism, pulmonary congestion or pneumonia. Any fluctuation in the condition usually denotes a complication. A patient normally recovers gradually and uniformly if at all. Any variation is suspicious. If a patient after a day or two begins to have a more feeble and rapid pulse, to be mildly delirious, to be tremulous and have a rise in temperature, it usually marks an infection that is septic or other-

wise. When shock is complicated with acute anemia it is not possible always to differentiate nor is it usually necessary. Shock may lap over into the condition of traumatic delirium, or be succeeded by delirium tremens. These complications are often wrongly spoken of in their early stages as secondary or delayed shock.

**Reaction** from shock is marked by perceptible increase in mental and bodily strength. The patient having lain pale and quiet for hours, may suddenly move or turn ; he opens his eyes, his face flushes, and he asks concerning the cause of his condition. The volume of his pulse increases and there is a return of color, bodily heat and consciousness. At times there is mild fever. The patient becomes mildly restless, is impatient. He wants fluids and wishes to clear the bladder and bowel. He not infrequently, these wants satisfied, drops off to sleep to wake up hours afterwards clear and perfectly recovered.

**Diagnosis.** Differentiate syncope, hemorrhage, the collapse of acute alcoholism, and starvation.

**Prognosis** is reserved until a few hours or a day or so have passed. If there is gradual improvement and no evidence of complications the patient recovers fully. Shock is always a most unfavorable complication in operation. It usually measures the capacity of the patient for recovery. Shock of psychic origin is a most unfavorable condition unless recovered from immediately.

**Treatment** for the *mild* cases, removal of the cause, rest in bed, quiet, applications of mustard and of heat over the epigastrium. Tonics such as camphor, whiskey, hot stimulating and fluid diet.

In cases of *severe* shock, such as mangling by machinery, the patient should be put immediately in bed and stimulated by alcohol and full doses of strychnine. Atropine is our best remedy and should be given until physio-

logical effects are obtained. All hemorrhage is stopped, the patient's clothing is removed and plenty of hot water bags placed around him. Simple retention splints, and antiseptic dressings should be applied as rapidly as is consistent with the necessities of the case. When he has recovered from the shock, and then only, permanent dressings and amputations are to be done.

In **operations.** If there is shock before an operation, no operation save those for relief of severe hemorrhage, gangrenous or perforated appendix, or strangulated hernia, intusseption or volvulus should be attempted. The operation even then must be done at once and rapidly. If in operation, the patient shows evidence of shock, the operation must be hastened or stopped, the anesthetic must be lessened or stopped, the head is lowered, artificial ischemia employed, hypodermics of ether, brandy, atropine, strychnine and digitalin are given, hot blankets and heat applied, hypodermoclysis and hot enemata employed. If the patient recovers in part he is transferred to his bed and the remedies continued. If later he recovers from the anesthetic and becomes restless give whiskey and small doses of opium as required.

**Traumatic Delirium,** or delirium nervosum, is a condition following severe operation or injury. The patients are not alcoholic. The cause or causes are not clearly understood. So far as known there are functional disturbances of the cortical cells of the middle and posterior lobes of the brain, or possibly a slight serous exudate between these cells, or there is cerebral anemia.

No **lesion** has been found postmortem.

**Occurrence.** It follows fractures, injury of the brain, severe burns, and facial erysipelas (?). It occurs within 24 hours and lasts one to three days.

**Symptoms.** The patient suffers from mental depression and pain and has low muttering delirium, picks at bed clothing or pulls and tears at bandages and dressings ; or he is melancholic ; or he is maniacal and tears dressings and bedding into shreds, is abusive to everyone and threatens violence. There is no special change in pulse or temperature. He eats well or throws the food upon the floor.

**Diagnosis.** Differentiate from ferment intoxication, hysteria, alcoholic delirium and insanity. Poisoning by iodine, and phenol combinations in the wound dressings, may give delirium of somewhat similar nature.

**Treatment.** Remove any irritation or irritating appliances. Apply ice bag to the head. Give opium, hyoscine, bromide and chloral. Make sure that dressings and splints are secure, otherwise strap the patient in bed.

**Delirium Tremens** is usually an acute exascerbation of chronic alcoholic poisoning. An acute alcoholic poisoning known as mania potu is recognized, and is due to a single drinking bout, with or without injury, in non-alcoholics. It usually follows the shock of an injury or operation, some acute illness or overwork.

**Lesion.** Probably there is temporary brain anemia, or pressure. Postmortem, there is found only the "wet brain of drunkards." There is not infrequently associated the chronic changes usually found in old people, namely chronic gastritis, bronchitis, nephritis, endocarditis and endarteritis. Septic and fatal pneumonia is a common concurrent disease in the pneumonia months.

**Symptoms.** The patient comes in weak, feverish, restless and talkative. He complains of loss of appetite, nausea, vomiting, and often has a depleting diarrhea. He is nervous and starts at any slight noise. His hands are

tremulous, and his tongue tremulous and badly coated. His eye is shifty and injected. The pupil is dilated. He complains bitterly of insomnia and begs for stimulants at night. He sleeps badly, rolling and tossing, and talks in his sleep. If awake his eyes are staring and expressionless and the mind dull.

Or, he has fever with marked insomnia and low muttering delirium day and night, pulls and picks constantly at the bed clothing, or alternately promises to keep quiet and urges that he must go out about his business. He has hallucinations and delusions of animals and things and conditions that are oppressing, offensive and horrible. The face becomes red and swollen and is often unrecognizable. The eyes are swollen full and the lids filled with pus. The tongue is coated white, yellow, brown or black and correspondingly dry and cracked. There is marked thirst early. The breath is offensive from its load of toxins. The stomach is unsettled and irritable, the patient often vomiting everything. He has a rapid and feeble or thready pulse. Or it is irregular and intermits as well. The respiration is rapid and shallow and stertorous ; or with increased prostration there is Cheyne–Stokes respiration. There is partial or total suppression of urine, soft or watery diarrhea ; or there are involuntary evacuations. The mental condition, from stupor and delirium may lapse into coma and death. In the delirious or maniacal stages, a patient may walk upon a fracture, splinted or not, and be oblivious of the fact. In the comatose stage he rouses up with difficulty or is roused up only to relapse.

**Diagnosis** is clear from the history. The delirium occurs later than in traumatic delirium. Fever, of any especial rise, marks complications.

**Prognosis.** In severe injuries the prognosis is bad. Brain injuries are almost regularly fatal, or may cause chronic meningitis and permanent mental debility.

**Treatment.** Alcohol, either as whiskey, beer or ale, is given regularly. Hot fluid diet. Opium for restlessness. Bromide and chloral in full doses for sleeplessness. Hyoscine and morphine by hypodermic for the mania. Capsicum as a stomachic, strychnine and digitalin for the heart. It is necessary often to use wristlets, anklets and jackets in the violent cases.

**Fat Embolism** is an obstruction of the small arteries and capillaries due to entrance into the circulation of fluid fat. It follows extensive injuries, especially fracture. Probably in every fracture the marrow has its connective tissue stroma broken down through degeneration changes and crushing. The fat gains access to the blood and lymph channels and if their lumen is too small the fat globules lodge and occlude the vessel. This occlusion takes place especially in the lungs, or the fat may push on through these vessels and occlude the vessels of the brain, kidney, liver and spinal cord. It occurs only in adults and old people, never in young children. The chances of having this complicating condition is not fully appreciated and is frequently overlooked. It occurs in the second, third or fourth day following injury and lasts two or three days.

**Lesion.** If the fat lodges in the lung in considerable quantities a portion of the lung fails of its nutrition and there is set up an irritation of the bronchi and cell spaces, or there is edema of the lung, or active congestion, or pneumonia. Similarly in the brain, kidney, liver and intestine there is altered circulation, secretion and function, and frequently a subsequent autointoxication.

**Symptoms** are mild or very grave. They are not constant and they are often far from clear. A day or two

after the injury or fracture, in the mild cases, there is general restlessness, perhaps anxiety. The breathing is increased in frequency and there may by dyspnea. The pulse is rapid and there may be slight or subnormal temperature.

Or there is an increasing accumulation of fat in the lung. The patient gets more restless and anxious, and there is marked dyspnea and cyanosis and course rales in the bronchi. This is most marked in old people of poor vitality. Or the old have marked prostration with a less amount of dyspnea. The pulse becomes very rapid and feeble. There is insomnia and delirium, and there may be coma and death.

Occlusion of the capillaries of the brain, especially in old age, causes the early exhibition of mild delirium, lapsing rapidly into coma and death. In the large involvement of lung tissue in the old, there is a rapid sequence of edema, congestion and hemoptysis, pneumonia and death from functional incapacity and prostration. Temperature is uniformly subnormal, and usually rises with the outset of the complications. With involvement of the kidneys there is frequently chylous urine.

**Diagnosis.** Fat embolism is to be differentiated from shock and narcosis ; from acute sepsis and acute congestion of lung and kidney ; and from cerebral embolism. Fat embolism comes later than this first class of cases. It has no preceding chill as in the second class, and the history of fracture precludes the third. It is essentially a form of autointoxication.

**Prognosis** varies somewhat in mild and severe cases. The mild cases are most often overlooked. They usually recover kindly and without special inconvenience to the patient. The brain cases are usually rapidly fatal. The patients die upon the third or fourth day after the injury. The severe lung cases repair slowly if at all ; the fatal

symptoms appear late, after two to four days, and death is gradual. All complications, especially those resulting in a coma, are regularly fatal.

**Treatment** is of no special sort. Employ stimulants, hypnotics, and especially salines to aid in elimination of the intoxication.

## BURNS AND SCALDS. LIGHTNING BURNS. BURNS OF HIGH TENSION ELECTRIC CURRENTS. X-RAY BURNS. SUN BURNS. INSOLATION.

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**Burns** are injuries caused by dry heat, by hot fluids and vapors. The burns of moist heat are familiarly known as scalds. They are of any degree of intensity as regards the depth of tissue involved. For convenience we speak of burns of the first, second or third class, or degree, depending upon the heat temperature and length of exposure. They vary much in severity according to amount of surface burned, and are classed as mild, severe, or fatal. Burns are relatively more painful according to the medium causing them, as flame, hot surfaces such as metals, explosives, steam scalds, hot aqueous fluids, fat burns, or molten metals. The depth of burn depends in large degree upon pressure against the burning medium. If the pressure is sufficient to destroy, practically, the protecting steam film between skin and heat surface, the burn is apt to be deep.

**Lesion** varies as to the class.

Burns of the *first class*—characterized by *hyperemia*—are red, painful, swollen, with slight serous exudate. These symptoms and the hyperemia disappear in a short time. Occasionally, later, the epidermis scales off in small patches.

Burns of the *second class—bleb formation*—are red, more painful and swollen, and a considerable quantity of serum cleaves up the epidermis from the true skin in the form of blebs or blisters. These contain serum, or serum with admixtures of leucocytes or of red blood cells. These blebs may be of considerable area and contents and by their pressure cause great pain, especially if the epidermal layers are broken. If the serum becomes infected, pus results and flat ulcers are formed that are very painful. A new epidermis forms in three to ten days, but the burn is still slightly red and painful, due to the congestion not yet subsided in the true skin. Puncture of these blebs and antiseptic treatment quiet the pain, and by avoiding suppuration hasten repair.

Burns of the *third class—eschar formation*—vary anywhere from partial destruction of the skin to charring of the whole extremity. The eschar, or coagulated surface, varies in color from white to grey, yellow, brown or black. It is soft and moist, or it is hard, crisp and dry. If the bulb endings are not destroyed, there is much pain ; or if destroyed with the skin, there is often no pain whatever. On the other hand, with destruction of the skin in small or large areas, there is some, or considerable, or profound, shock. The wound repairs by sloughing of the eschar, and by granulation. This takes days and weeks, depending upon depth of tissue involved.

Burns by caustic alkalies and concentrated acids belong to this class. The sooner the chemical action is neutralized the less the burn. The application of water unless in supra-abundance increases the chemical action. Burns by phenol are neutralized by 20 percent alcohol.

Extensive destruction of skin causes profound shock and often subsequent autotoxemia and death. The deep

sloughs result in secondary hemorrhages. Broad granulating surface conduce to disfiguring scars and bad contractures and deformities. Skin grafts and plastic (flap) operations hasten surface repair.

**Symptoms.** Aside from the pain, redness and swelling of burns, there are constitutional symptoms varying in intensity with the class of burn and extent of surface.

In severe burns the patient is usually excited, complains of great pain in the burned member, cries or screams. The mind is perfectly clear, or, in the fatal cases, shock lapses into coma. Or the patient is restless, moans and groans and begs for relief or death. These patients often become delirious. The pulse is rapid and compressible, the extremities cold, temperature subnormal. There is vomiting, continued nausea, and often great thirst. The urine is scanty, or suppressed, or hemoglobinuric. There may be a profuse diarrhea after two to three days, with or without the formation of enteric ulcers that may cause internal hemorrhage or perforate.

**Prognosis.** The repair of mild burns is most favorable, usually without a complication or a constitutional symptom. Severe superficial burns under strict cleanliness repair readily. If they involve large areas, as half the body, the chances are about even. Deep, severe burns if not of large area, and without complication, repair well. Fatal cases die from shock within the first three days ; from septic thrombosis or from autotoxemia within a week or ten days, or from general sepsis; its diarrhea and exhaustion in from one to three weeks.

**Treatment.** Scrub and bathe all burned surfaces well, when necessary, with soap and water, then with saturated boric acid solution, and dust thickly with bismuth subnitrate. Over this apply loose dry sterile gauze and

bandage lightly to keep in place. This is done rapidly, preceded by an alcoholic stimulant and a hypodermic of morphia. Put the patient in bed, watch and attend to the various constitutional symptoms, and dress the burn only upon the appearance of pus accumulations underneath the now adherent gauze. Cut the gauze over these pockets, sponge out the pus with gauze wet in the boric acid solution, dust on more bismuth and reapply loose gauze compresses, and bandage. If the patent runs a temperature, watch for pus pockets. In deep sloughing be always ready for ligating in case of secondary hemorrhage. The sloughing process may sometimes be hurried by aid of scissors, cutting only into dead tissue. Treat sloughing surfaces antiseptically, but avoid poisoning by absorption of solutions by large granulating surfaces. Amputate before, or because of, serious hemorrhage, or because of spreading cellulitis caused by a badly managed sloughing surface. Maintain the general strength and avoid opium. Later, do Thiersch skin-grafting.

**Lightning Burns.** Lightning causes a variety of pathological conditions. It is an electric discharge of high intensity and low current. It causes a partial or complete retardation or cessation of coagulation of the blood. If superficial there is apt to be caused a surgical emphysema of the whole body or portions of it. Or there is rupture of blood vessels along which the electric discharge goes. Or there are more or less superficial lacerations. Or there are burns caused by the electric current at points of entrance or exit. There is shock that is instantly fatal or that lasts for several days. Or there is cerebral concussion. The clothing and shoes are often ripped clean from the person. The damage seems to be due both to the resistance of

the human body and to the insulation by dry foot-wear. Treatment is quiet, strychnine, atropine, and artificial respiration as needed. Treat the varying lesions and constitutional symptoms as necessity demands.

**Burns by High Tension Electric Current, Electrocution.** Electric lighting wires, trolley wires, and general service wires often break, or ground because of broken-down insulation. These feed wires carry high voltage and large current capacity. A constant current of 2,000 volts causes severe burns locally and general shock of the central nervous system, or instantaneous death. The shock is treated regularly. The burns heal by sloughing of eschar and granulation. Artificial respiration is frequently needed. Give atropine and strychnine in full doses. Do not give whiskey or any other form of alcoholic stimulant. The burns cause little or no pain, and are treated as any ordinary burn.

**X-Ray Burns,** or dermatitis, consists of mildly devitalizing or destructive action of the escape currents upon the matrix of the nails and the true skin of the hands of the constant operator, or occasionally upon the part skiagraphed. It is due to long exposure to the currents, without grounding. There is produced horny striations of the nails and epidermis or occasionally sloughing of the skin upon over-long exposure. Improved screens, foil-covered gloves and care in the use of the X-ray apparatus is all that is necessary.

**Sun Burns.** These are burns of the first and second class and are very painful, especially when extensive or

when irritated by the clothing. They are due to direct action of the sun's rays upon the malpighian layer of the skin. They obey the same laws as ordinary burns, as to lesion and symptoms. The treatment is application of a mixture of glycerine, kaolin and boric acid. Under this topical application made twice a day, the pain redness and swelling rapidly subside. The exudate in the blebs is released and under this application scarcely ever reappears. The inflammation in this way disappears entirely in two to four days.

**Insolation,** or thermal fever, is a disease due to heat and excessive water-waste of the body and is characterized by hyperpyrexia, internal venous congestion, and collapse, delirium or coma. Two grades are recognized.

One is known as heat exhaustion and gives minor symptoms; the other, thermal fever, gives all the major symptoms of inflammation and collapse. The former is due to exposure to the sun's rays or to great artificial heat such as is encountered in ship's engine rooms or in drying rooms of sugar refineries. The latter is consequent upon great heat and high saturations of the atmosphere as in the prolonged heated terms of summer. Both are abetted by alcoholism and exhaustion.

**Lesion** is absent in the mild cases, or there is vasomotor disturbance and congestion of the portal circulation. There are in the severe cases changes in the blood, due to the overheating of the body and loss of great quantities of water. The blood upon postmortem is found increased in the internal venous circulation, dark, tarry, coagulable and occasionally gaseous. There are congestion of the lungs and coagulation changes in the liver and kidneys. There is early rigor mortis, and postmortem temperature due to blood changes.

**Symptoms.** In the *mild* cases—heat exhaustion—there is more or less prostration, the skin is cold and clammy and there is cold sweat. The face is blue-white and there is a calamitous expression. The pulse is rapid and feeble, the temperature often subnormal; the patient goes to the limit of his strength and faints, or collapses and becomes unconscious. Occasionally there is stupor, low delirium and coma. There is diminution of urine and glandular secretion. Recovering, the patient becomes conscious and gradually and apathetically recovers from his prostration.

The *severe* cases—thermal fever. After premonitory symptoms for a few days or a few hours, in which the patient complains of mild headache, dizziness, nausea and vomiting, prostration and dread, he falls unconscious upon the street or at his employment. There is congestion of the skin, especially of the face, or there is extreme blue pallor, there is stertorous breathing, pulse bounding full and rapid, and temperature of 104° to 106° or even 112°. The eyes are injected and the lids swollen. The tongue is coated and often parched. There is a muttering delirium, or mania, or stupor, or reflex muscular contractions in the short reaction stage following collapse; or there is no reaction, only continued stupor and utter prostration. The patients die immediately, or comatose in a few hours, or delirious after a day or two, or variously from general collapse and prostration.

The patients recover with inability for years to withstand heat or the sun's rays; or with symptoms of local chronic meningeal thickenings and suboccipital headache, or with a chronic hepatitis and nephritis. Indefinite gastric disorders, irritability, depressed mentality, and general functional disturbances often remain behind for years or a lifetime.

**Prognosis,** bad in temperatures above 104°. Above this point, blood changes take place. Below this, recovery is rapid and without complications.

**Treatment.** Pack in ice or rub with ice immediately. The full graduated bath is to be preferred. The bath is begun at 75° and reduced by ice to 60° to 55° or until the patient's temperature is reduced to 101° to 102°; alcoholic and alkaloidal stimulants having previously been given. The patient is then removed to a bed where the cool air blows over him till his temperature gradually goes to normal. Give chloral or trional for sleeplessness, and salines. The patient, on the following morning, or at most after a day or so, is able to return home or to business in a quiet way. He must not be active for a week or two. Insolation is apt to be very severe in the obese. Here, venesection is of great service. Give opium in restlessness or in the maniacal cases. Ammonia may be useful in coma.

## FREEZING. FROST BITE. CHILBLAINS. LIQUID AIR BURNS.

**Freezing** is an injury or congelation of the tissues caused by extreme cold and is often followed by inflammation, gangrene and death of the part.

There are three classes of freezing injuries according to the reaction of the tissues. These are similar to those of burns: first class, hyperemic; second, bleb formation; third, eschar or slough. During the process of congelation there is at first upon exposure to cold only a burning, painful, or tingling sensation; and as bulb endings become involved, an entire absence of sensation. The part is now cold, pale, more or less hard. There may be only small areas of the

surface involved as in the winter frost bites of the cheeks, ears and fingers ; or the superficial tissues of an extremity are frozen ; or an extremity is frozen to the bone and is of wooden hardness and feel. An extremity may be frozen completely through, in which case a toe upon slight traumatism is readily broken off, being as brittle as an icicle. As in burns so in frost bite, the degree of pressure upon a metalic surface causes a greater or lesser depth of freezing, as in the deep freezing of liquid air.

**Reaction** from congelation of the tissues if brought about slowly leaves behind a condition similar to burns. If the tissues are brought rapidly to normal bodily heat, by external supra-heat, the reaction causes an increase in both the inflammation and the symptoms. There is then greater pain, swelling and involvement of tissues and greater danger of slough and gangrene. This is due to the sudden flushing of the frozen surface, vasomotor paralysis of the vessel coats, and consequent venous congestion.

The **symptoms** and **prognosis** are similar to those of burns.

**Treatment.** The areas of frost bite are rubbed with snow or ice and plunged in cold water to effect reaction slowly. Care is used to avoid heat by every means possible. After reaction the parts are treated, as in burns, antiseptically. There is greater danger, however, of gangrene following freezing ; and the use of wet antiseptic gauze dressings, such as sublimate, are more frequent here than in burns.

**Chilblains,** an erythema of feet and hands, is due to irritation of the peripheral nerve endings, and not infrequently follows frost bite on any subsequent chilling of the surfaces. It is often very annoying. There is prickling,

tingling and even pain, and painful burning, especially of palmar and plantar surfaces. Drying, massage with alcohol and capsicum or with ointments and solutions of chloral are useful. The erythematous eruption may become occasionally bullar, and ulcerate and demand antiseptic treatment.

**Liquid Air Burns,** burns by frozen mercury and similar objects, are simply frostbites that are due to the pressure of holding, or contact with, objects of extremely low temperatures. The rapidity of heat radiation causes the tissues to freeze very deeply. They cause little or no pain at the time, a local deep eschar forms after reaction, there is pretty intense pain and inflammation, and the injury repairs by sloughing and granulation, under antiseptic dressings and treatment.

## SUBCUTANEOUS INJURIES OF SOFT PARTS.

**Subcutaneous Injuries** vary from the slightest bruise or contusion, that subsides within a half hour ; to rupture of muscle, tendon or nerve, the effects of which may remain for a life time ; or to rupture of the large blood trunks, liver, kidney, or spleen, that may cause almost instant death. The effects of crushing the soft parts surrounding the long bones of the extremities is a varied one and is often passed unrecognized until some functional disturbance, due to neglect of these injuries and their consequent bad repair, brings them to the surgeon. In the outlying loose connective tissue upon flexor surfaces of joints, and its contained glands small blood vessels and capillaries

there is little resistance to trauma. Skin, fascial bands and sheaths, tendons, the larger blood vessels, and nerves have a surprising amount of resistance. Especially is this true in the neck, where even bullet wounds rarely injure seriously the structures ; the fascial sheaths in large part being responsible for protection of the structures, as are they also for the subsequent spreading of sepsis.

Among contusions or bruises, the injuries to the blood vessels play a considerable part. In minor bruises, there is simply a serous exudate into the skin and subcutaneous tissue sufficient to cause the welt or raising of the tissues at the point of injury. This is so slight as to readily subside without treatment in a very few hours and to cause no inconvenience from pain.

In the severe contusion, there is swelling and its pain and other sequelae. Still there may be no considerable injury of the part. Occasionally the trauma causes rupture of the blood vessels, as well as exudate. If these vessels are small there is discoloration of the contusion by the red blood elements, or sugillation, or a black-and-blue spot. If this subcutaneous hemorrhage covers a considerable surface area, we are apt to term it suffusion ; or if there are small points of capillary hemorrhage scattered diffusely upon the skin surface, we call them ecchymoses ; or if very small, petechiae.

All subcutaneous hemorrhage is apt to appear at or soon after injury, but to increase in extent for a day or two. It repairs by cell degeneration, and return of the blood elements through the blood or lymph channels, but always with the characteristic yellow green blue and red mottling caused by various depths of blood pigment left in the skin.

Greater injury of the soft parts leave them pulpy often, the bulk of which is mixed blood elements. Only in hematomata do we get true blood tumors. In these pulpy

tumors and in hematomata there is repair by slow absorption ; or by organization of the mass with or without new cell proliferation and permanent thickening ; or there is an absorption of the fluid elements and the necessity, late, of removing the dry blood elements through incision.

Finally there is the spontaneous subcutaneous hemorrhage of bleeders, blood vessel tumor or aneurism, the hemorrhage into joints, tissues and cavities as hemarthrosis and hemothorax and apoplexy, that need special treatment.

All subcutaneous contusions, especially when severe and hemorrhagic, cause much pain, swelling and discomfort. They need rest, bandaging and applications of continuous cold for a few days, and intermittent heat later. The cold in part relieves the pain and it tends to keep the vessels in continuous contraction, thus preventing farther hemorrhage. The heat, later, tends to dilate the vessels and promote reaction and absorption in the wound. The bandaging is applied snugly enough not to interfere with the pressure of further swelling and not therefore sufficient to be painful. It aids in hemostasis and in reaction and reabsorption. Elevation of the part aids also.

Similarly lymph effusions are occasionally seen in the loose connective tissue. They are due to rupture of lymph vessels ; and contain light straw-colored fluid, or are yellowish red from admixtures of blood elements. They respond in every way to blood effusions except that they are often very slow of formation and cause no pain or very little.

In all blood effusions of any extent there may be a slight fever due to the fibrin ferment absorption and intoxication. But the symptoms are not severe and they pass soon, often unnoticed. Or in the larger crushing injuries involving bones and joints there is a considerable fever, as 102°, that reaches its maximum after a day or two and

remains for a few days longer and gradually subsides, but causing considerable anxiety and annoyance to both patient and surgeon.

Or the third or fourth day, the fever, ushered in by a chill, rises to 104° and the wound is septic. Especially is this liable to happen when the skin is abraded over these injuries, often when the utmost cleanliness or antisepsis has been observed.

Or such a fever beginning a little earlier and rising usually not quite so high might fulfill the history of fat embolism, and not sepsis.

Associated with these lesions there is usually integrity of the parts, especially the skin. In destruction of the skin or in simple skin abrasions there is always danger of infection and the absolute necessity for cleanly if not antiseptic treatment of the part. The broken surface should be thoroughly cleansed with soap and water and a sublimate dressing applied under the bandaging.

Another complication is due to damage of the nutrient vessels of the skin. If the skin is torn and badly bruised, there may be flaps or portions that are deprived of their blood and are cold to touch and look grey or blue-white. They may have suffered practical death, and yet the circulation be renewed and the skin vitalized. At other times this skin will necrose and demand excision, the repair being had by regeneration or by skin grafting.

In all these subcutaneous injuries the loss of function is an important feature. It is as well an important aid to diagnosis. The crushing of a joint for instance absolutely limits its function and at the same time gives distortion of the limb. Such a crushing is necessarily accompanied also by destruction of the periarticular circulation, and the resulting hematoma farther distorts the part and limits function. If a trunk blood vessel be damaged by the crushing injury,

the peripheral parts of the limb will be cold and there will be lack of efficient circulation for a week or ten days till collateral circulation is sufficiently well established. This is especially true if the crushing effects one or more large veins. The peripheral tissues will then be congested and much swollen. These injuries of blood vessels require bandaging and position of the extremities to help repair ; and at times may demand amputation if badly cared for and infected.

The crushing of muscle almost absolutely limits its function and causes reflex spasm of that and nearby muscles. Rupture of a tendon often interdites use of the extremity ; or if the part is used there is spasm of the muscles. Dislocations of muscles and tendons, though not common, impair function and may cause pain if used.

Dislocation of a nerve, most commonly the ulnar, causes twinges of pain upon moving it across bony ridges. This and the readier traumatism in the new and unprotected situation, warrant operation and replacement through fascial flaps.

Crushing of nerve trunks causes paralysis, wholly or partially, and trophic disturbances. Vasomotor changes may result in venous congestion and cold extremities, or muscular atrophy ; and general disturbances of nutrition follow disruption of the purely trophic conducting fibers. This is illustrated by the slow formation of callus in repair of fractures when nerves supplying the bone are cut off experimentally or by accident. Similar to this disturbed function of nerves is that of disturbance of the cerebrum in concussion and compression of the brain.

**Concussion of the brain,** probably due in all cases to contusion of its substance without special laceration of the

blood vessels, follows trauma of the skull. There is usually no fracture of the bony envelope. The patient, if the injury be slight, loses muscular coordination and may fall to the ground. He is pale, dizzy, confused, mildly irrational and may have nausea and vomiting. After a period of semiconsciousness, resting, he recovers generally with no knowledge of events succeeding the accident.

If the injury be considerable there are severe symptoms. The patient falls relaxed, cold, pale, clammy, and with wavering feeble pulse and quiet respiration. He moves but slightly, is paralgesic, and responds only to loud shouting. His answers are irrelative, muttering and often unintelligible. The pupils are usually widely dilated and unequal and respond to bright light slowly if at all. There is no accommodation to distance. All the centers are dulled. In about 20 percent of hospital cases there will be unconscious micturition and defecation. The lumbar centers in common with other reflex centers are dulled and need strong afferent impulses to cause them to act. There is active retention of urine followed by active or passive overflow ; and there is active retention of feces followed by constipation and atony of the gut. After 12 to 36 hours or longer the patient will react. The circulation improves and he will wake to consciousness with headache, some dizziness, malaise, and a disposition to be left alone and not to be questioned or moved. He goes on to full recovery, or he may relapse into a comatose condition and remain so, until he dies. Or he may recover consciousness for a day or so, and then meningitis sets in.

If he recovers consciousness after a day or so, the patient has no recollection of events following the injury ; and in not infrequent cases cerebral impressions are destroyed proceeding the injury, antidating it for a half a day to several days. Fractures of the base of the skull are

regularly followed by concussion of the brain. In a few cases cerebral concussion is followed by cerebral compression.

**Compression of the brain,** due to pressure of wound exudates depressed fracture or hemorrhagic tumor, usually succeeds to symptoms of concussion or may be independent of concussion. It follows severe traumatism of the skull, with or without fracture. If due to depressed fracture or sharp hemorrhage, it follows directly upon the injury ; but if due to the formation of exudate or slow-forming blood clot, the outset and its symptoms will be gradual. The symptoms are those of cerebral pressure, interfering with the action of the cerebral centers and compressing and cutting off fibers of nerve conduction. Consciousness becomes less and less until the patient is completely insensible. There is only the slightest reflex motion of the extremities. There is paralysis of the auditory apparatus. The eyes are closed, the pupils dilated and irresponsive to stimulus of any sort. The breathing is long-drawn and stertorous, the muscles of the face and lips are paralyzed so as to cause alternate puffing and sucking of the lips. The skin is usually normal and perspiring. The pulse is full, slow and irregular, often intermittent. The bladder gets filled slowly and may need catheterization to prevent paralitic or distention overflow. The bowels are atonic, and there is accumulation of feces and constipation; or there is paralysis of the sphincter and incontinence of feces. If caused by the pressure of exudate, these symptoms clear in a week or ten days. If due to hemorrhage, the symptoms remain until absorption of the clot or until its removal by operation. The compression caused by depressed fracture is eliminated only by operation, and elevation or removal of

the fragment; or if left without operation is apt to prove the source of cerebral irritation and cause attacks of localized (Jacksonian) epilepsy; or cause by pressure localized paralyses such as hemiplegia or paraplegia.

Among the most efficient methods of **treatment** of contused soft parts after they have passed the acute or inflammatory stage and before they have entirely lapsed into the chronic stage of interstitial or parenchymatous cell infiltration, or atony atrophy, paralysis or contracture, is the use of hydrotherapy and massage.

In **hydrotherapy,** use is made of *hot water* either in the form of hot applications to the part, or of hot baths alternating with cold sprays or sponging. The hot water is applied locally at a temperature of 110° to 116° or higher. The circulation is stimulated, the inflammatory reactions are hastened and the tissues are at once relaxed and stimulated. Applications, locally, of hot compresses for a quarter or half hour, followed by cold sponging or cold spray and gentle or vigorous rubbing, are of great value in establishing the circulation and tonicity of tissues. The full warm or hot bath 80°, to 100°, is congesting and often depleting to the invalid but aids the constitutional treatment through promoting excretion, secretion and sleep. There should be reaction following its use; the patient should break out into a gentle perspiration and fall to sleep quietly. Or stimulation by alcohol and the alkaloids should be used before, during, or after the bath to promote these results and avoid collapse.

*Hot vapor baths*, by the means of sheeting and cabinets, serve a good purpose if used intelligently. They serve to

relax the tissues, promote transpiration and general metabolism, and to relieve the so-called sciatic, neuralgic and rheumatic pains of autointoxication.

Somewhat similar is the action of the *bake ovens* used in the treatment of contusions, sprains, joint injuries, and the like. The dry heat may be borne to almost any degree and maintained for short or long intervals. There is caused a quickened absorption of exudates and lessened pain in the part, but experience seems to show that the time of ultimate repair and regained function is much lengthened, and there are great chances of repeated relapses. This is presumably due in some degree to the fact that where pain is absent a patient will not take care of an injury.

*Cold water* is used locally to promote capillary contraction and circulatory tone, either alone or alternately in combination with hot compresses or sprays. Used generally in the form of cold sponging, the surfaces of the body in fevers lose heat, and by reaction the capillaries dilate, and temperature is farther reduced. Needle baths and cold plunges are of use in vigorous patients who react quickly without debilitating effects.

*Ice* chills the surfaces in fever patients, removes latent heat from the underlying tissues, and after the first unpleasant effect to the patient has passed is borne gratefully and well. In the form of spinal rubs it is of great value in neurasthenia, especially for its moral effect.

**Massage** is of special use in stimulating circulation and clearing up congestion on the one hand or venous congestion on the other. It changes both the quality and the quantity of the circulatory medium and the current rate. It loosens up old tissue adhesions, and diffuses the various simple inflammatory exudates and through a more active

circulation promotes the absorption of them. Incidentally the tonicity of tissues is effected in nerve degenerations, as neuritis, until such a time has elapsed as the nerve fibers shall regenerate. Wrongly used in septic infections, such as the common practice of squeezing a boil, it has a tendency of spreading the infection to outlying lymph spaces and to new spaces. As with hydrotherapy, the special field for massage is in subacute and chronic inflammatory stages. Massage is variously divided into four or five processes. For convenience we may choose four. *Stroking*—or rubbing, or friction,—is variously applied in a superficial way by movements of the full hand of the operator from a peripheral point centrally. It has the special object of relieving any stasis or slowing in the subcutaneous veins, and of increasing both arterial and venous flow and promoting oxidation of both superficial and deep tissues. *Kneading* is accomplished by use of the pulpy finger tips or the fleshy parts of the palm of the hand. It may be most superficial, or deep enough to affect general muscular structures. *Beating*—tapping, percussion or flagellation—is variously employed to cause mild exudate in the parts and regeneration of the tissues, or simply to promote tonicity and circulation. It is performed by means of the finger tips, or the flaccid finger surfaces, or by mechanical beaters of soft rubber. Finally is *active and passive motion*. In chronic joints and fractures, in contractures, muscle spasm, and in purely functional and neurasthenic cases this form of massage is of great value. By active motion is comprehended all functional uses of muscles, bones and joints, from the ordinary simple uses of these structures, with and without the sustaining of bodily weight, to the more complex trials of severe gymnastics. By passive motion is included all movements of these structures as are brought about by the operator without voluntary

movement upon the part of the patient. One of the most useful forms of massage is a combination of both active and passive motion, whereby the operator carries out passive motion of the parts against the resistance (active) of the patient. The setting-up exercises in vogue in the army and the mat exercises of our gymnasia are familiar forms and good examples of the lightest active exercise ; as are the present vogue of resistance exercises of the mixed method.

Massage is to be employed for special reasons and in occasional cases every half day, and then shall consist of the lighter forms conducted for short intervals of a half hour or so. Such are the correction exercises of the desk worker, bicyclist and the man of sedentary habits. Or the masseur makes use of stroking, kneading or tapping, mildly or severely, for a quarter hour, half hour or hour, depending upon the needs and the strength of the patient. Or in men of strong and robust physique, heavy stroking, deep kneading, flaggillation, and strong resistance and active exercise may be efficiently used ; and as a result we shall expect a reduction in the subcutaneous and interstitial fat deposits, and a general anabolism of the muscular digestive and glandular apparatus. Such a system of massage constitutes training and may be supplemented by hot steam baths followed by a cold plunge.

All massage, whether of the milder or severer sort, must depend for its usefullness upon the strength of the patient, his reaction, and the resultant effect of the massage upon the injury or condition for which it is given. Much also depends upon the skillfulness of the masseur or masseuse, his or her experience, and the judgment used in the special case in which it is used. Any massage that produces permanent lameness or soreness of a severe type should be discontinued. If by its means a chronic inflam-

mation undergoes an acute exascerbation, harm rather than good is done as a rule. And yet these methods are vigorously persisted in, in many cases, though the patient as the neurasthenic protests, with the best of results. Here is the office of the advising surgeon, to regulate and control the massage, and to guarantee both the patient and the masseur.

## DISEASES AND INJURIES OF THE SKIN AND CELLULAR TISSUE.

The skin consists of a superficial epithelial layer, the epidermis, that covers and protects the deep layer of true skin or corium. The *epidermis* consists of two layers:— the outer, a thick, horny layer of flat cells whose substance is converted into keratin and is continually being shed and renewed from underneath from the malpighian layer; and the inner malpighian layer which consists of successive strata that are clear, then granular, then of polyhedral cells, and finally of columnar cells from which originates all the superstructure of the epidermis. The *true skin*, or *corium*, superficially is covered with projecting papillae that are received into corresponding pits of the epidermis. These papillae contain the fine capillary loops, the sensitive corpuscles of the cutaneous nerves and depending upon the part of the body the lymphatic loops also. These papillae are most numerous in sensitive areas of the skin, such as the lips, palm and pulp of the fingers; at other parts are few or wanting. The corium is made up of connective tissue cells, elastic fibers and white fibrous connective tissue. This is bedded upon a matrix of fibrous and loose areolar tissue in which are the sweat glands, the hair bulbs

and sebaceous glands, the cutaneous blood vessels, lymphatics and nerves and the cutaneous fat. This areolar connective tissue blends gradually into the superficial fascia so as to be freely movable. The skin has the special office of conveying the sense of touch. It is also protective, excretory and circulatory, and through transpiration serves to regulate bodily temperature. The nails and hairs are special modifications through deep dermal cells.

**Comedo** is a disease of the sweat glands whereby the semifluid fat becomes dried, accumulated in the glands, and superficially discolored so as to form yellow or black spots in the skin, especially of the face and neck, chest and back. Applications of hot water, steaming, expression with a watch key serve to clear up the condition.

**Acne** is a chronic inflammation of the sebaceous glands of the face, neck, chest and back especially, that may be papular, pustular or nodular, and is characterized by red areolar swellings in the center of which is often a comedo or milium. It is caused usually by gastro-intestinal disturbance, by reflex, or by infection. Comedo and acne are especially diseases of puberty and disappear usually in adult life. Acne is benefitted by steaming, facial massage, and internal use of sulfur compounds, and especially by continuous doses of arsenic for long intervals. The pustular and nodular forms often demand needling, expression and antiseptic treatment.

**Milium**, pearly-like elevations of the skin, caused by occlusion of the sebaceous glands, is quickly relieved by puncture and expression.

**Sebaceous cyst,** or wen, consists of an occluded sebaceous gland sufficiently large to form a tumor. These sebaceous cysts may occur almost anywhere upon the surface ; upon the scalp, they are familiarized by the name of wen. Often there is formed a containing membrane of lining cells and fibrous tissue. These cysts continue to enlarge and often disfigure. They not infrequently infect. It is necessary not only to incise and express the enclosed fat, but to thoroughly curet or eradicate this membrane to prevent recurrence.

**Furuncle,** or boil, is an acute septic inflammation of a sebaceous gland or hair follicle, varying in manifestation from the pustule of acne, to larger nut-sized septic collections containing greenish sloughs of the subcutaneous fibrous tissue or fascia (the "core"), to broad fluctuation and septic cellulitis. The contained infecting bacteria are pretty regularly staphylococcus pyogenes aureus and albus. *Furunculosis* is a term commonly used to denote the recurring infection of various glands. It is a term of neglect and has no excuse for existing. Treatment of boils is to incise them freely and early, curet them thoroughly, pack and treat antiseptically.

**Carbuncle** is a multiple boil of varying area, having two or many sieve-like openings. It is due to septic infection as in furuncle. Carbuncle is found especially upon the back of the neck, the shoulder, back and buttocks. It varies in size the longer it is neglected, from a quarter inch to four and to ten and fourteen inches across. A carbuncle, due to multiple abscess formation in each sebaceous gland of the containing area, is very painful and is capable of causing

profound sepsis. It is more virulent in old age, where the system is already depleted. Treatment is immediate crucial incision and curetting of the very small ones; otherwise crucial and circumferential incision and total excision. The wound is afterward covered with hot compresses, and later packed loosely and dressed antiseptically.

**Erythema**—rose rash, or erythematous dermatitis—is one of the most common of the acute inflammations of the skin. It exists in an infinite variety of forms and from many causes. In its simplest form it constitutes a rose-colored rash that occurs in circumscribed patches or areas. The causes are varied; continued heat, continued exposure to wet and cold and wind, the continued irritation of slight burns, frost bite and chemicals, or of the excreta such as nasal and oral mucus, discharges from the ear and other septic conditions, from urine and from acid stools, from vulvar and leucorrheal discharges, and from ingestion of certain foods as sea foods and of certain chemicals as atropine, quinine and belladonna. The lesion is a hyperemia of the superficial layer of the true skin. As a consequence of this localized hyperemia the skin is reddened, slightly roughened often, and swollen, without or with blebs. There is usually slight exudate into the skin superficially. There is intolerable itching and burning, the skin surface seems hot to the touch, and the patient's condition is far from a comfortable one. Treatment consists in removing all causes and especially of clearing out the gastro-intestinal tract and preventing fermentation in it. Clean the skin surfaces with boric acid solution and powder with zinc oxide.

**Dermatitis venenata**, rhus-poisoning, and **dermatitis medicamentosa**, drug-poisoning, comprehend some of the

skin eruptions due to the various external and internal irritant poisons. These poisons are rhus, arsenic, belladonna, boric acid, bromides, chloroform, choral, copaiba, iodides, iodoform, potash, quinine, salicylic acid, sublimate, tar and the turpentines. Treatment. Remove the cause and use salines internally, and soothing antiseptic and mildly astringent washes and powders.

**Eczema** is an acute or chronic simple inflammation of the skin usually due to irritation and characterized by multiformity of lesion,—generally papular, vesicular, or pustular,—by itching, exudate and the formation of crusts. The skin is reddened and infiltrated, the redness shading off into the surrounding sound tissue. If the inflammation is severe, the skin is much roughened, fissured and covered with heavy leathery crusts. If the area of inflammation is irritated by the warmth of sharp exercise or of much bedding there is a renewal of the exudate, lifting of crusts, and intolerable itching. Eczema is caused, in skins especially susceptible, by irritants of all sorts. It is furthered by anemic, dyspectic and rheumatic disorders. It is uniformly of wet or dry type. Wet or *moist* eczema is to be dusted with antiseptic drying powders, such as a mixture of boric acid and zinc oxide. In the *dry* varieties, usually with much crusting and skin thickening, the best results are usually gotten by softening the crusts with oil and a hot bath, clearing with alcohol, and applying balsam of peru, or combinations of oil of tar and a mercurial in a lanoline base, well rubbed into the skin. These powders or inunctions should be applied only after clearing the skin with alcohol. Water should religiously be kept from all eczematous surfaces.

The constitutional treatment consists in regulating the

diet and the mode of living; in giving tonics of iron, arsenic and strychnine, and the salines.

**Callosities** are the result of intermittent pressure which hypertrophies the skin especially of the palm, thumb and fingers and the heel. It consists of excessive amounts of horny epidermis. The callosities sometimes become quite painful on pressure and require paring and protection until the underlying papillary layer becomes less sensitive.

Occasionally a callosity blisters. The serum is removed through sub-epidermal puncture ; and by protecting the part from renewed pressure, the papillary layer soon has a new protecting horny layer.

At other times these blisters infect, pus results, ulcers are formed, and the surrounding tissues are invaded with septic infiltration. These infected blisters should be cleared of all superimposed epidermis and dressed in wet boric or sublimate gauze. They readily repair.

**Clavus,** or corn, is a hypertrophy, often a hyperplasia, of the horny epidermis. It occurs more especially upon the toes, due to intermittent pressure of incorrect shoe gear. It is usually both an outgrowing and a subconical ingrowing of the epithelium. Treatment is through proper shoe-wear, cleanliness, paring, or the use of the salicylic acid corn cures of the trade.

The so-called soft corns are most often atrophy-macerations. They lie between the toes and are due to uncleanliness and constant pressure. Treatment, correct shoe-wear, bathing, boric solutions.

**Chronic ulcer,** usually found upon the legs of old, poorly nourished, and alcoholic patients, is due to tearing or abrasion of the skin, or may follow the nail scratches of eczematous and rheumatic patients. The wound, once formed and invariably infected, instead of healing kindly by granulation, becomes sluggish or infiltrated with purulent exudate and spreads broadly. These ulcers after a time appear as broad flat ulcers with bases covered by greyish-white fibrous tissue containing few granulation tufts and bathed in thin sero-pus, the edges often undercut, blue, areolated in dark red, and the skin edges thickened by many layers of horny epithelium.

Treatment is curetting, packing with balsam, boric, or sublimate gauze, and the maintenance of strict antisepsis.

**Keloid** is a hyperplasia of scar tissue usually found upon the skin of the neck, chest and shoulders, and is especially frequent in the negro. It may follow the repair scar tissue of tubercular glands of the neck. At other times it seems to occur spontaneously or from no reasonable cause. Treatment is excision.

**Lupus** is a chronic inflammation of the skin and certain mucous membranes characterized by the formation, in the areolar tissue, of nodules resembling granulation tissue and caused by the tubercle bacillus. At times the disease is latent and the skin is normal except for a few scattered bullar growths partially movable in the skin. At other times the growths are multiple, undergo infection, break down, and ulcerate with areolar or diffuse redness about them. At still other times the nodules are small, diffusely distributed, and break down to form areas of

reddened and infiltrated tissue with occasional small ulcers. The ulcers heal at times spontaneously with the formation of scars that look not unlike burn cicatrices but having nearby small or larger patches of red infiltration. Treatment is free use of the pacquelin early in the disease, or excision and skin grafting. Some seemingly satisfactory results have been had by subcutaneous injection of Koch's tuberculin, which causes punched-out sloughs and repair by granulation. Lupus pretty uniformly recurs. It is of rare occurrence.

**Injuries of the skin** heal readily, if clean, if the skin edges are brought into apposition. Inturned skin edges prevent coaptation and form sulci. Outturned skin edges favor hyperplasia and repair by ridging. Skin reproduces rapidly on granulation surfaces if covered by rubber dam or protective. Skin is reproduced by extension of the cells of the malpighian layer, or by reduplication of the epithelium of the sebaceous glands and hair follicles. In abraded surfaces such as **brush burns**, there is much disturbance and infection of all skin layers, and not infrequently slough due to the traumatism of the subcutaneous vessels. Occasionally the subcutaneous areolar tissues undergo spreading septic infiltration and the formation of subcutaneous flat abscesses. This is especially familiar following the abrasions of wrestlers and sparrers, infected from mats and gloves. Occasionally in mangling wounds, the skin flaps have their circulation so damaged as to cause necrosis and repair by granulation.

# DISEASES AND INJURIES OF MUCOUS MEMBRANE.

**Mucous membrane,** or the mucosa, lines the hollow viscera and is freely communicable with the outer surface of the body. There is some variation in the different parts of the body, but in main it may be said to consist of a basement substance, and cells supported upon a basement membrane. The basement substance contains small amounts of yellow elastic tissue or thin layers of plain muscular tissue. The cells usually cylindrical epithelia are interpersed with goblet cells upon the thin-layered and flat-celled basement membrane ; and together they are infoliated upon the basement substance. In the infoliations of this suprastructure are situated the mucous glands which together with the goblet cells secrete a thin glairy mucus that keeps moist the surfaces of the mucous membrane. The mucosa is usually attached to surrounding structures by elastic areolar connective tissue in which is distributed the blood vessels, nerves, and lymphatics, that extend often into the basement membrane underlying the cells. The cells are varied from the flat cells of the cornea, and the squamous cells of the bladder, to the cylindrical ciliated cells of the intestine. Crypts are sac-formed infolded pockets of the mucous membrane, found for example in the tonsil. Rugæ are exfolded ridges and are frequent in the intestine.

An **acute catarrh** is a simple serous or sero-purulent inflammation of a mucous membrane, depending upon the character of the exudate. There is first a hyperemia of the membrane and exudate thrown out in the subcutaneous areolar tissue and beneath the basement membrane. Due

to the hyperemia there is an increased production of thin watery mucus, which at later stages is thick and white, or thick and purulent, due to admixture of leucocytes from the exudate and some epithelial cells thrown off from the swollen mucosa. It constitutes the simplest form of inflammation of a mucous membrane. The hyperemia subsides in a week or ten days generally without any proliferation of the cells of the basement substance or of the submucous areolar tissue.

In **chronic** catarrh, of which there are two types, the atrophic or dry and the hypertrophic or moist, this cell proliferation is very considerable. In *atrophic* catarrh the proliferated round cells form fibrous tissue that infiltrates the epithelial cells and the small capillaries and by a process of cicatrization leaves the mucosa dry, pale, shrunken, and without normal enervation. In *hypertrophic* catarrh the proliferation of round cells is by slower process, there is increase of substance in the submucosa, increase in epithelial cells, circulation and enervation, so that the parts are enlarged, reddened, covered with profuse mucus and often sensitive to both touch and temperature, and susceptible at all times to renewed catarrhal inflammation ; whereas the atrophic variety is prone upon injury or irritation to break down and ulcerate.

**Acute croupous** inflammation is characterized by the formation of fibrin thrown out upon and between the cells of the mucosa causing death of cells and the formation of white patches as in follicular tonsilitis. This exudate may at times consist of fibrin, exfoliated epithelia and both red and white blood cells as in pneumonia.

**Diphtheritic** inflammation is a specific croup, due to formation of areas of coagulation necrosis, that causes the death of the full depth of the mucous membrane, and repairs only by granulation and reduplication of the epithelial cells. There is usually an associated proliferation of the cells of the submucosa ; and in repair an increase in its substance, and an accompanying obliteration of the special cells and cysts of the mucosa. These inflammations, croupous and diphtheritic, leave mucous membrane prone to catarrhal attacks, both acute and chronic.

The treatment of the catarrhal types of inflammation consists in removal of the cause, the use of borated and stimulating gargles, or the ingestion of antiseptics and stimulants, and the free use of salines. In the chronic forms, where possible to treat by the use of endoscopic instruments, congested areas and atrophic and hypertrophic conditions are counter-irritated by 20 grain nitrate.

The **injuries of mucous membrane** repair almost by magic ; deep clefts as cuts in the lips and tongue heal in three or four days upon apposition. Use is made of mild antiseptics as borated gargles, attention being paid largely to elimination of the mucus caused by the irritation of the wound and the sutures.

## BLOOD VESSELS. ARTERITIS. ATHEROMA. PHLEBITIS. ANEURISM. VARIX.

The **arteries** have three coats. The *inner*, or intima, has a serous coat of flat polygonal endothelial cells supported by a layer of white fibrous (sometimes yellow fibrous) tissue and that in turn supported by reticulated yellow fibrous tissue. The *middle* coat is made up of plain muscular tissue and some yellow fibrous tissue arranged crosswise or circularly. The *outer* coat consists mainly of white fibrous tissue arranged longitudinally. The artery is supplied with nerves and nutrient blood vessels and is usually contained in a fascial sheath.

The **veins** have structural detail similar to that of the artery. The *intima* has transverse folds enclosing plates or bands of white fibrous tissue that form twin valves at various points in its caliber. The *middle* coat is thinner than in the artery and consists largely of white fibrous tissue and a very little plain muscular tissue. The *outer* coat is practically similar to that in the artery. The veins are larger than the arteries and from their structure are capable of less contractility and of withstanding greater pressure. The deep veins are usually enclosed in the same fascial sheath as the artery ; the superficial veins are loosely contained in the layers of the superficial fascia.

**The capillaries** lie between the arterioles upon the one hand and the venules upon the other. They are only a fraction of an inch long. They differ from the arteriole and the venule in having no middle coat and consist only of endothelial cells with a few scattered plain muscle cells for the most part placed longitudinally. The capillaries usually form a network so fine that the caliber of the vessel scarcely admits a red corpuscle within it. In the muscles

the capillaries are mainly longitudinally placed, while in the pulmonary air vesicles they are tortuous, weaving in and out.

**Arteritis**, or endarteritis, is acute or chronic. The *acute form* is always local and due to traumatism, thrombosis, or embolism. It is not unusually of septic origin, the degenerative changes in the surrounding tissues causing degeneration and ulceration of the arterial coat. The *chronic form*, more strictly *chronic endarteritis*, or *atheroma*, is characterized by fatty degeneration. It especially occurs in old people. It weakens the walls so that any special increase in pressure or volume of the blood current is apt to rupture the walls. Syphilis is one of its causes. Aside from atheromata there are frequently amyloid and hyaline changes in the vessels in syphilis and nephritis. There are at times hypertrophic changes in the coats of an artery due to a previous inflammation or irritation. In *endarteritis obliterans* there are connective tissue thickenings of the intima and in *arterio-sclerosis* there are thickenings of fibrin in patches upon the intima.

**Phlebitis** may be simple and due to traumatism without infection. Or it is septic and due to a thrombosis caused by an infectious nidus, brought from some suppurating area and finding lodgement at some valve or anastomotic point, proceeds to plug the whole peripheral portion of the vessel. *Suppurative phlebitis* constitutes a similar condition and goes on to abscess. In *sclerotic phlebitis* the caliber of the vein is narrow or occluded by fibrin patches. In *proliferating phlebitis*, usually following thrombosis, there is hyperplasia of the connective tissue of the vessel walls, often ending in

narrowing the calibre as well as thickening the coats of the vessel.

**Aneurism** is a blood vessel tumor, caused by embolus or the rupture of one or both the inner coats of the blood vessel through traumatism or syphilis, is followed by dilitation of the blood vessel, and is characterized by pulsating expansion of the tumor associated with a systolic bruit. After a time the tumor is more or less well filled with a white laminated blood coagulation, or clot or thrombus, composed largely of fibrin and fibrous tissue, and the pulsation and bruit are often absent.

The aneurism gradually increases in size until the outer coat of the vessel gives way and the patient dies of acute hemorrhage. Or we may have dissecting aneurisms, the blood stripping up the coats of the vessel and causing at times a bulging at some point distant from the original aneurism ; at others enlarging the aneurisms. Pressure of the tumor upon adjacent structures often gives rise to dyspnea, dysphagia and paralyses. Aneurism occurs in men in about 80 percent of the cases.

It is frequent as a sequel of syphilis and occurs often in the negro. It occurs in order of frequency most often in the aorta, then the popliteals, the carotids, the subclavians. Alcoholism and rheumatism may be predisposing causes.

Treatment, where possible, may be attempted by ligature of the artery on both sides of the aneurism. This should include any or all branches capable of setting up collateral circulation with the aneurism, and should be far enough away from collateral branches so that the thrombus of ligature shall not exclude them from establishing collateral circulations outside the thrombus.

**Varix,** or varicose veins, is a condition of the veins whereby, due to partial occlusion at some point, the caliber of the veins is increased through pressure, their course made tortuous and the return circulation impeded. It regularly follows chronic leg ulcers, labor, and occupation requiring much standing walking and lifting. There is often dull dragging pain due to marked congestion of such veins. Not infrequently, especially through traumatism, the superficial tissues will break down over a varix, cause an ulcer, and end in an erosion of the vein and serious hemorrhage. Such an ulcer is known as a *varicose ulcer.* Treatment is by multiple ligature done subcutaneously, or by skin-flap method by ligature and excision of the vessels. Operations upon varix, as on aneurism, require the strictest asepsis, as they readily infect and cause serious and often fatal complications.

**Injuries to the blood vessels** require prompt compression and ligature. Ligature of the large trunks, such as carotids, femoral, subclavian and internal jugular are frequently fatal through occurrence of gangrene, sepsis, or secondary hemorrhage, before collateral circulation is well established. Injuries to the coats cause aneurism or varix respectively, or are followed by occlusion, or patency and perfect repair.

# INJURIES AND DISEASES OF THE LYMPHATICS. ELEPHANTIASIS. LYMPH CYSTS. LYMPHANGIECTASIA. LYMPHANGEOMA. LYMPH FISTULA.

The **lymphatics** correspond in structure almost exactly with that of the veins. They increase in caliber and inversely in number from the periphery or mesentery to the central ducts. The larger lymph vessels are supplied with frequent valves and are deeply protected by the tissues. In the periphery the small lymphatics connect with lymph spaces in the connective tissue and suffer traumatism, infection, and thrombosis as do the blood vessels. They contain clear lymph, the product of filtration of the blood through the walls of the capillaries, and a few lymph cells or small leucocytes. Chylous lymph is a milky white fluid that is absorbed through the lacteals and enters the central lymph system. It separates into a jelly-like clot largely proteid and a clear fluid identical with serum.

**Elephantiasis** is a chronic inflammation of the skin and subcutaneous tissues due to obliteration of the lymph vessels and resulting in more or less fever and a pseudo-gigantism. The disease is supposed by many authors to be directly due to the presence of filaria in the blood and lymph vessels in sufficient numbers to clog their lumen. The disease is frequently endemic, especially in the tropics, and occasionally occurs sporadically. There results stasis and often occlusion from the clogging of the vessels, and there is set up an extensive hyperplasia of all the superficial

tissues. This hyperplasia continues to increase year by year until the extremity or part affected becomes huge to gigantism. The skin surfaces are rough and scaly and the tissues become almost of wooden hardness. They often degenerate and form large and ugly ulcers. The extremity, formerly a drag, becomes now a menace and has to be amputated. The condition is not infrequent in the negro, East Indian, and mixed races.

Traumatism of lymph vessels causes thrombosis and often results in **lymph cysts,** collections of lymph contained within firm fibro-epithelial walls. They require, if of any considerable size and inconvenience, incision and drainage.

**Lymphangiectasia** are caused by crushing of the lymph vessels and inflammation sufficient to form dilitations of the vessel, or culdesacs.

Under the name of **Lymphangeoma** is recognized varix of the lymph vessel, and by **lymphedema** diffusely spreading hard lymph tumors. These may occasionally be benefitted by operation. Under this head comes **macroglossia** and **macrocheilia.**

**Lymph fistula** is an occasional complication of abdominal operations. Some lymph space may be opened in a wound left to heal by granulation, and may refuse to cease excreting lymph though the wound is otherwise nearly

repaired. It is frequently necessary to effect lymph thrombosis by the application of phenol, several times, before the lymph flow ceases.

## INJURIES AND DISEASES OF THE NERVE TRUNKS. IRRITATION, PRESSURE, CISION. NEURORRHAPHY. NEUROPLASTY. NERVE GRAFTING. NEUROSIS. NEURALGIA. NEURITIS.

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The **nerve trunks**, whether of cranial nerves or spinal nerves, are as a rule made up of bundles of mixed nerve fibers whose office is either sensory or motor. The motor functions are those purely motor or secreto-motor, or vasomotor, or others that are purely trophic. These nerve fibers cease in the cord or are prolonged by transmission fibers to the medulla or the cerebral convolutions. The axis cylinders of the fibers are surrounded and separated by neurilemma and in case of the medullary nerves by myelin substance also; the sensory and motor fibers running often side by side, enclosed in bundles known as nerves, or in large bundles or nerve trunks, and enclosed by thick, inelastic sheaths of connective tissue. The various nerves and nerve trunks have accompanying nutrient blood vessels.

**Traumatism** of nerve trunks causes tingling pain only, if the structures are not materially damaged. Continuous pressure of slight amount causes **irritation** and results in intermittent muscular spasm of the parts to which its motor fibers are distributed, or slight alteration in function of secretory glands, or pain.

Continuous **pressure** if considerable and prolonged causes interruption of secretions, interference with muscular function or paralyses, dull pain or paranesthesia and atrophic and degeneration changes in muscle and nerve.

**Disruption,** or cision, of the conducting fibers causes paralyses and anasthesia for such times—about three weeks—as it shall take the proximal axis cylinder to repair its fiber filaments. This provides that there shall be no interference nor displacement of the nerve fibers by infiltration of the new connective tissue cells of the reparative inflammation.

If there is displacement of the cut ends of the nerve and cell interference, the proximal end becomes enlarged, clubbed and covered by a sheathing of fibrous connective tissue ; while the peripheral end degenerates to an extent commeasurate inversely with the amount of its anastomosis with other nerves. Such **cision** of nerve trunks, as in fracture, causes lessened transmission of vasomotor impulses and results in venous congestion and delayed callus. Separation of cut ends of nerves demands suturing or neurorrhaphy, suturing by advancing the nerve or neuroplasty, and nerve transplantation or nerve grafting.

**Neurorrhaphy** consists in suturing the cut ends of the nerve at the time of injury or at some subsequent time after healing of the wound ; primary or secondary neurorraphy. The stitching is done with heavy catgut carried through the thickest part of the nerve trunk well back from the cut ends. Repair takes place and conductivity of the nerve fibers results soon after the wound repair,—one to two weeks.

Provided on the other hand suturing is not done at the time of injury, the nerve ends are displaced and paralysis results. The wound must be incised, the nerve ends found

and freshened, and sutured. This constitutes a secondary operation or a *secondary neurorrhaphy*. It is pretty uniformly successful, but conductivity of the nerve fibers is considerably delayed beyond the time required for their repair in the primary operation.

**Neuroplasty** is usually a secondary operation demanded by degenerative changes in a cut nerve and consequent upon shortening of the nerve trunk, so that the ends after freshening cannot be brought into contact. There are various methods of lengthening the nerve trunk, the simplest of which is by turning flaps cut from either end of the nerve and suturing them together. Care should be used, to protect these flaps until well grown, by filling in strands of catgut near them to displace outlying tissues and new connective tissue cells.

**Nerve grafting,** or transplantation, for deficient or destroyed nerve is seldom done, for lack of available grafting tissue and because equally good results, 67 percent may be had by freshening the ends of nerve trunks when necessary, carrying tension sutures through the trunk ends and filling in the remaining space with heavy gut or chromatised catgut and allowing spontaneous regeneration of the nerve fibers to take place. Excellent repair is had in one to three months.

A **neurosis** is an abnormal affection of the nerves or nerve centers of a functional nature. It needs no other consideration here.

A **neuralgia** is a severe paroxysmal pain in the area of distribution, or along the course, of a nerve and is caused by anemia or inflammation of the nerve, or pressure-irritation upon it at some point. Exposure to cold, alcoholism, rheumatism, septic infection at some distributing point, severe muscular exercise, certain infectious diseases such as smallpox, typhoid and malaria, metallic poisoning by mercury, arsenic and lead, are all given as indirect causes for neuralgia. The pain is severe and steady, or intermittent; it seems to have a fashion of being more severe at night; it clears up in part or wholly, only to return each time with renewed vigor; it comes often without seemingly sufficient cause, and stops gradually or suddenly for no apparent reason; it occurs in rich and poor, well-nourished and impoverished, in lymphatic and in nervous temperaments. A severe neuralgia, as facial or supraorbital neuralgias or as a sciatica, lasting for two or three days, leaves a patient completely prostrated mentally, morally and physically. Instead of lasting a few days it may continue for weeks and months before ceasing. After the pain is gone the patient rapidly recovers strength and weight and mental habit. The condition is rarely fatal except as it compels suicide. Treatment is by nerve stretching, aconite poisoning, cauterizing along the nerve trunk, metaphysics, and excision of the nerve. All or any may prevail, or even the last procedure may fail in part and require repetition.

**Neuritis,** or **perineuritis,** is of an exudative, purulent or productive type according as the cause is trauma, infection, or prolonged irritation. The inflammation is primarily without the nerve sheath and, depending upon its type and extent, the result is one of mild pressure; or of erosion of the sheath and descending, sometimes ascending, degeneration of the nerve fibers; or there is considerable pressure and often marked change in nerve conductivity,

and even obliteration in whole or in part. This perineuritis largely follows injuries and is to be cared for symptomatically.

A type of **true neuritis** follows the infectious fevers, such as typhoid, diphtheria, the exanthemes, also syphilis and chronic alcoholism. It is multiple and usually bilateral in its manifestations, and is serous, sero-fibrinous, or purulent. It is known as **multiple neuritis.** Aside from infectious origin it may be due to toxic poisoning of a chronic type as lead and arsenic ; or is spontaneous and due to cold (?) or is atrophic as in diabetes and severe chlorosis ; sensory as in tabes ; or traumatic rarely as in shoulder dislocations.

The symptoms are often disguised and vary in degree and extent according to the original causal lesion and its resultant neural lesion. There is swelling and degeneration of the nerve fibers, and proliferation of nuclei ; or there is abrupt death or gangrene of the trunk of the nerve ; or there is proliferation of new cells, induration and sclerosis, with more or less degeneration of the nerve substance.

As a result there is formication, numbing, prickling, burning pain, paralgesia, paralysis, analgesia, or anesthesia, in varying combinations and at various stages of the disease.

The treatment is largely symptomatic and based upon the lesion and its course, but efforts are made to sustain both muscular and systemic tone until resultant descending and ascending degenerations repair. Supporting and tonic remedies are to be used within physiological limits. Strychnine and iodides are of special use. Give nerve sedatives and hypnotics as needed. Give moral support to the patient and urge him to exert both his mental and physical abilities. Relief by operation is seldom needed

except in local septic conditions, and that often fails. Good results are gotten from massage and the galvanic current. Static electricity has a tonic and good normal effect.

## DISEASES AND INJURY OF MUSCLE AND TENDON. MYOSITIS. MUSCULAR RHEUMATISM. MUSCLE ATROPHY. PLASTIC SURGERY. TENOTOMY. FASCIAL CONTRACTURE.

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The **muscle structures** consist of the main body-muscle of contractile striped muscle tissue, its aponeurotic attachments of fibrous connective tissue, and its tendon of flexible but inelastic fibrous connective tissue. The attachment of tendons is to bone, cartilage, or fascia. The tendons are protected at various points, as in articular grooves by vaginal synovial sheaths, over bony or tendinous ridges or pressure points, by interposition of a bursa, and occasionally near a joint by prolongations of the synovial sac. The muscle is well supplied with nutrient blood vessels and nerves, while the tendon has little and poor vascularization and often little or no enervation. In the neighborhood of joints, muscle and tendon have opportunity for rich blood lymph and nerve supply under inflammatory conditions. Similarly the fascia has little supply at normal but is in intimate relation with vessels and nerve trunks.

**Myositis,** or inflammation of muscle, is serous, serofibrinous, fibrinous or ossifying in type. It is caused by

nearby inflammation, such as hematoma, ulcer, or abscess; by traumatism of the muscle; by disturbances of the circulation, such as atheroma, aneurism, and varix; and by certain septic or toxic principles in the circulation or in the muscle, as in typhoid, malignant measles, syphilis, and muscular rheumatism. The inflammatory exudates are thrown out between the primary muscle bundles in the connective tissue.

The symptoms are mainly those of pressure upon the nerve filaments. There may be some swelling of the muscle, but this is usually slight in amount. There is slight pain, increasing in paroxysmal character as the irritation causes muscle-contracture or muscle-spasm. There may be permanent shortening of the muscle and there is decided loss of function, due in part to the inflammation and in part to its reflex contractions. There may be sufficient disturbance to cause paralysis of function, temporarily or permanently, wholly or partially. There may be interruption of circulation, as congestion, from too tight bandaging or splinting; or artificial ischemia is maintained too long and resulting degeneration of muscle takes place, due to lesion of the muscle bundles proper. Occasionally there is hypertrophy of muscle tissue due to continuous irritation of the cells or to intercellular thickening. In degeneration, regeneration is usually had by connective tissue formation.

In the *fibrous* type repair takes place by this same connective tissue process, forming tough unresisting masses or spots. Occasionally a whole muscle is thus changed. Or there are diffuse interstitial thickenings as in syphilis and rheumatism, with or without muscle atrophy.

O*ssifying myositis*, usually of traumatic origin, deposits bone either in the tendon or in connective tissue thickenings of the fibrous variety.

*Progressive multiple ossifying myositis*, a disease of rare occurence, begins in childhood. Most muscles are involved consecutively, ossify and atrophy ; each outbreak of bone formation being marked by fever and local and general pains. The joints also become to a large extent ankylosed. Slight traumatisms conduce to ossification. Finally practically all the muscles save those of the abdomen, back, and of respiration and facial expression, lose function. The joints of the neck, back, and extremities ankylose. The man becomes literally a living skeleton, and lives as a museum freak until he dies from starvation, or until some intercurrent disease as pneumonia, endocarditis or nephritis cuts him off.

**Muscular rheumatism** of the *acute* type is usually serous, rarely sero-fibrinous, and is familiar as lumbago, wry-neck, and the various sorenesses of certain muscles due to traumatism, exposure, or position.

The intimate cause of the inflammation is conjectural only. Gastro-intestinal disturbance of the chronic and mildly apeptic sort, the so-called rheumatic diathesis, is always an important contributing cause.

The chief symptom is the more or less severe pain in the muscle, often excruciating and nauseating, made worse by the slightest movement of the muscle or of the body.

*Chronic* muscular rheumatism is due to long exercise upon poor diet in bad weather. It is common among soldiers and sailors. The muscle lesion is practically the same as in the acute form. The symptoms are indefinite, shooting, dull, or lancinating pains in the muscles of a part. Not infrequently these are precursors only of definite outbreaks of syphilis, spinal caries, rheumatism, neuralgias, neurasthenia, or inflammations of the joints.

Treatment of the chronic cases is tentative and expectant. In the acute cases use calomel and the salines, hot packs and hot fomentations, rest, stimulants; and late galvanism and massage.

**Muscular atrophy** follows various pathological conditions. It may result from cutting off the trophic impulses or from disuse of a part as seen in fractures or the inflammations of joints. It is a true atrophy of the muscle if nutrition is interfered with. Or it is the atrophy of degeneration. The so-called reflex atrophies of arthritis are usually those of disuse, but occasionally they are due to an extension of the inflammation from a joint to a nearby muscle. The treatment is along general lines.

Cut or torn tendons are repaired by **tenorrhaphy, tenoplasty** and **tendon grafting**—operations identical with similar methods of repair of nerve trunk injury. Tendons are sutured, singly or multiply, by carrying the needle transversly through the widest section of the stump a reasonable distance back from the cut or torn ends. It is often difficult to find the upper tendon because of muscle contraction. The wound is enlarged in the upward direction; or use is made of a sharp-pointed, bent hook to catch the tendon. This incision should be made parallel to the tendon but not over it, so as to avoid adhesion to the scar. Occasionally it is useful and necessary to suture the upper tendon to the tendon of an allied muscle, or to fascia or periosteum. Dog's tendon and heavy catgut are used in tendon grafting with fair results. Various sorts of flaps are used in tenoplasty, supplimented by catgut inlays as in neuroplasty to enlarge the amount of tendon tissue or

fibrous connective tissue by which repair takes place. Repair requires two to six weeks. Massage, especially in the form of passive and mild active motion, is desirable after three to four weeks.

**Plastic operations** on muscles have been uniformly dismal failures ; degeneration and gangrene following, even when the best of circulation is seemingly maintained.

**Tenotomy,** by subcutaneous or by open method, is employed in contractures when not otherwise possible to correct deformity. It is frequently made use of in correction of the congenital deformities of the foot, as club-foot. The tendon repairs of its own accord ; or tenoplasty is used.

**Fascial contractions** require operation ; such as Dupuytren's contraction, due to shortening of the palmar fascia ; and contraction of the fascia lata, in 7-day walkers, causing pinching of the external cutaneous nerve and neuralgia. The operative treatment consists of division of the fascia by subcutaneous or open method, and exsection of the nerve as required.

## INFLAMMATION OF THE LESSER SEROUS CAVITIES IN RELATION TO TENDONS. TENOSYNOVITIS. FELON. BURSITIS. GANGLION.

**Tenosynovitis** is acute serous, fibrinous, or purulent, or chronic sero-fibrinous. The *acute serous*, or hydrops tenosynovii, is due to a profuse exudate of serum in the vaginal sheath, causing pain, swelling, some redness and loss of function. There is considerable pain on pressure. The condition is relieved by splinting and firm bandaging. These cases should be incised and drained if necessary because of pressure and pain.

The *fibrinous* variety starts as a sero-fibrinous usually, but soon becomes dry and crepitating. There is only a small amount of swelling, no redness, little pain, or loss of function. Splinting and repeated applications of iodine clear up the condition without much new tissue formation.

The *sero-fibrinous* type lies between these two in exudate, symptoms and treatment.

*Purulent* tenosynovitis arises from one of the other varieties or is from the beginning a septic inflammation. It demands incision and drainage.

The *chronic* form usually rises from an acute case, may last for years with remissions, and usually results in new tissue formation, fibrous bands and adhesions. It is benefitted by complete rest upon a removable splint, intensely hot applications, massage and iodine.

**Felon,** is a familiar form of purulent synovitis. The lesion often invades the tendon itself and the surrounding tissues, and may cause bone ulcers or caries.

**Tuberculosis of the tendon-sheath** is of not infrequent occurrence. It is chronic, tends to advance, and is pathognomonic of a general tubercular lesion. Along the tendon, its groove and sheath, small greyish-red miliary tubercles, either attached separately or imbedded in gelatinous granular or granulation tissue, are found. Later, these have grown into caseous or suppurating masses lying along the track of the tendon. It is sometimes, but rarely, possible to eradicate the disease either early or late. The appearance of the part, for instance wrist or finger, is that of an indefinite turgescent swelling without other special symptoms than that it continues to enlarge.

**Bursitis** is acute or chronic. The *acute* type, as most commonly exampled in the prepatellar bursa,—house maid's knee,—is characterized by marked general redness, heat, pain and swelling, not simply of a bursa but of the part, and a considerable functional disturbance of the neighboring joint. The inflammation is of the so-called catarrhal type, or sero-fibrinous ; and, neglected, may become purulent rarely, and often through persistent irritation becomes chronic. The treatment is rest and firm pressure by bandaging and, late, hot and cold douching and iodine.

The *chronic bursitis* is largely sero-fibrinous without special symptoms save soreness. Occasionally there are productive products causing fibrous thickening, and rarely an obliteration of the bursa. The treatment is that of the low grade acute forms.

Bursae are frequently incised by accident, as the olecranon, and repair by cicatrization under asepsis.

**Ganglion** is an enlargement of synovial type found upon the back of the wrist and hand or upon the palm. It

is a tumor of varying size, slightly raised, slightly fluctuating, hard often to stoniness. It is frequently caused by traumatism, grows slowly and causes little or no inconvenience. The tumor usually rises from tendon, tendon sheath, or as a diverticulum of one of the smaller synovia. It is undoubtedly at times derived from a previously undeveloped bursa. The contents of the sac is colloid. Pressure in the form of firm bandaging may cause it to disappear if used early before it becomes so tense. Later, subcutaneous puncture, or incision and drainage, are used. A common method of curing these weeping sinews by placing the hand firmly upon a bench and striking the tumor sharply with a mallet is efficaceous though crude.

## FRACTURES. REPAIR. FAT EMBOLISM. FEVER. DELIRIUM. CALLUS.

The bones, especially the long bones which are the most subject to fracture and often most subject to bone-disease, are composed of diaphysis or shaft and usually two epiphyses or enlarged extremities. The bone-ends are cartilage-covered, as a rule, for joint articulation. Otherwise the bone is entirely covered by periosteum. The *periosteum* comprises an outer dense coat of white fibrous connective tissue that is continuous with tendon insertions and with joint ligaments ; and an inner elastic and fibrous membrane or network that in early life is very vascular and closely attached to the epiphyseal cartilage and loosely to the bone. From this membrane the small blood vessels extend directly into the bone and furnish the outer layers of the bone its blood supply. The bone-shaft comprises a

cylinder of compact bone tissue arranged in thin concentric rings or zones, with or enclosing Haversian canals in which the blood flows. These channels have oblong spaces called lacunae, formed by the multinuclear osteoclasts. The belts of lacunae have outlets, longitudinally, known as canaliculi. The bone-ends are composed of thin layers of the compact bone-envelope and are made up largely of spongy cancellous tissue lamellated in the direction of force, whether of pressure or tension. In these bony saccules of the bone-ends the blood courses freely with no true vessel walls and together they constitute the red marrow. In youth this red marrow also fills the shafts; but in the adult, lacunar absorption has taken place in the shaft, the cancellous tissue saccules and red marrow have given way to smooth bone-walls and medullary cavity and its continued yellow marrow or storage fat. In early life, mainly after birth, the epiphyses are formed. They are, early, separated from the diaphysis or primary ossifying bone center by an interposed epiphyseal cartilage. This cartilage grows in breadth with the diaphysis and the epiphyses; they gain in diameter by concentric outside layers, deposited from the periosteum, and in length, especially the diaphysis, by deposits of bone at the cartilages. In these bone ends the terminal loops of the small blood vessels with their dilitations lie close to the epiphyseal cartilage and aid in this bone growth. Most of these bones in foetal life develop in cartilage by a process of calcification. As the cartilage is non-vascular, there is finally absorption of the lime salts which are replaced by ossifying centers that are vascularized. Similarly, in youth, the medullary cavity enlarges through the medium of the osteoclasts while the osteoblasts upon the periphery are laying on bone beneath the periosteum. The epiphyses last formed are the first to be joined to the shafts, since they are better supplied by the nutrient

arteries. They are those nearest the elbow and farthest from the knee. The earliest join at 15 to 17 years and the last at 21 to 25 years. Between these years variously there may be separation of the epiphyses through trauma. The long bones support the body and afford muscular leverage. Better to serve this purpose, or because of this use, they are usually curved in two directions, and conserve strength and elasticity. By test, compact bone is capable of a compression strength about twice that of wood and granite, a tensile strength about that of iron, and a torsion strength lying between the two. The tibia withstands a pressure of a ton and a half, the femur and humerus nearly a ton, the radius a third of a ton, the ulna, clavicle and fibula less. The femur withstands a torsion of about 200 pounds and a bending force of nearly half a ton. The skull withstands pressures longitudinally of considerably over half a ton and quite half a ton transversely ; the slight structural work of the skull-base withstanding from 400 to 600 pounds. This bone-strength is less in youth where the bones are small and largely made up of the tricalcium phosphate. They bend readily and suffer green-stick fracture. In old age when there is a small proportion of phosphate and a relatively very large amount of calcium carbonate, the bones are very fragile, and may fracture spontaneously.

A broken bone is termed a **fracture.** Conversely a fracture is a solution of continuity in bone. Such a fracture is a simple one if it be subcutaneous ; and a compound one if associated with an open wound, with or without direct connection to the fracture. A compound wound is always unfavorable to primary repair and is not infrequently infected, as in wounds of soft parts. A fracture is said to be single, if there be but one ; or double, if there be two

breaks in a single bone or a single break of each of two companion bones ; or multiple, if several fracture-fragments exist in the same part ; or comminuted, if there are several small fragments in a single or a multiple fracture ; or complicated, when there is associated dislocation, serious hemorrhage, injury of a nerve trunk, perforation of a cavity, such as the chest, or involvement of a nearby joint.

A fracture may be transverse, oblique, longitudinal, or spiral, depending partly upon the form and direction of the fracture and largely upon the direction of the traumatic force ; whether it be direct lateral, partial lateral, or indirectly through the long axis of the bone, or torsion, respectively. A fracture is said to be complete or partial or fissured only, depending upon the extent of it. A depressed fracture, as of the skull or spinal vertebra, indicates a fracture with displacement of one or both surfaces or tables, and usually causes pressure upon the underlying parts. A green-stick fracture constitutes a fracture partially invading the diameter of a young bone with a splintering or bending of the other portion that is upon the side of the applied force. Epiphyseal fractures, of faulty obstetric practice or of youth, occur especially at the neck of the humerus, at the lower ends of radius and ulna, the olecranon, occasionally in the femur and the tip of the tibia. They are usually transverse and cause little damage to bone growth. They happen usually before the age of 20. Spontaneous fractures happen in old age where the muscles give flabby support to calcareous bone. They are caused by little or no violence, such as misstepping a stair or only turning over in bed. Impacted fractures are usually seen in falling accidents ; the parts most effected are the heads of femur and humerus ; the cancellous tissue gives way as a result of the driving force ; and the limb is shortened a quarter to half to one inch. These impacted fractures need

no treatment as a rule save rest, and they repair with slight shortening and the very slightest functional derangement.

At rare times a patient is seen who is said to have the fracture habit, or osteopsarthrosis. Here the bone is prematurely calcareous, the fractures occur almost spontaneously. A patient of thirty years may have had as many fractures, happening in as many bones ; or some bones having suffered a multiplicity of fractures, and not infrequently having recurrent fracture at some one point.

Of the multiple fractures, the lower ends of the femur and the humerus are very frequently fractured in Y-form, T-form and occasionally H-form, not unusually following lines of epiphyseal joining, or the grooves and fossas of these condyles. This is not infrequently the case in run-over accidents and shafting accidents : where the fractures already multiple are complicated by these fractures into or through joint surfaces and articular cartilage.

Fractures suffer different displacements according to the position of the fracture-ends. Thus in an angular displacement, the fragments are not maintained in the normal longitudinal axis ; in lateral displacement, the bone ends are displaced upon each other partially or completely ; in longitudinal displacement, the fracture-ends override, and the fracture is usually oblique and often compound ; or there is displacement of transverse axes, the lower fragment is rotated upon the upper, as is usual in fracture of the head of the femur or humerus.

**Lesion.** The fracture involves rupture of the periosteum, disruption of the bony framework, rupture of the endosteal membrane, and traumatism of the bone marrow whether it be red or yellow. In the majority of cases the fracture is oblique and considerably displaced, so that there is resultant laceration of muscle and blood vessel and not infrequently of nerve and skin. The trauma of marrow is

followed in one to two days by a degeneration change in the stroma and liquifaction of blood elements or fat with their sequent ferment intoxication or fat embolism. Similarly, rupture of blood vessels causes blood tumors and considerable subcutaneous or deep swelling or tumefaction, with or without serous or sanious blebs upon the overlying skin surface. The laceration of muscle will cause pain and often violent spasm of the muscles, and the spasm causes further traumatism of muscle and bone displacement.

Finally as a result of rupture of the membranes and the bone there is **formation of callus.** In the place of the now degenerated marrow, within the bone shaft, between the bone ends and beneath periosteum, there is thrown out from the nutrient blood vessels, after a period of three to four days, a mass of plastic material. At first largely fibrinous, later becoming fibrillar and cartilaginous, this finally constitutes the *provisional callus.* This callus, according to its position from without inward, is known as subperiosteal, intermediary and medullary. It forms nature's splint for the fractured bone. From the periosteum and the endosteal membrane or from cartilage, their cells proliferating, there are formed special osteogenetic cells called osteoblasts that invade this provisional callus and proceed to lay down in its substance bone salts taken up from the blood and thus to form in its place solid bone tissue. Or there is formed hyaline cartilage or fibro-cartilage. Now, as in normal bone formation, certain of the cells become farther specialized into osteoclasts and these, probably due to their power of excreting carbonic acid, cause liquifaction of the solid bone at certain points and the formation of lacunae and canaliculi. This proceeds for a period varying from two to three weeks in which this provisional callus of fibrous fibrillar and partly calcified material becomes organized first into osteoid and then into spongy bone, trabeculae

appear and the blood begins to circulate through the new bone channels. We now have the formation of the *permanent callus;* and, for a week or two longer, deposit of lime salts is going on until firm bone repair is finally complete. Meanwhile there is all the time going on an absorption of the elements of the provisional callus; so that in the event of the most perfect repair possible there is no point of tumefaction to indicate the point of fracture. The fractured surface is smooth, compact, and occasionally smaller or furrowed at the fracture line. The provisional callus, especially the medullary part, has been rich in red marrow formation, but it now gives way to absorption, or rarely to permanent bone cicatrix.

Similarly, in fracture involving a joint and consequent fracture of the articular cartilage, there is set up at first a perichondritis with fibrous exudate, that becomes first fibrocartilage and then deposits bone. Or the cartilage becomes cicatrized; or it becomes a free floating body in the joint; or it becomes encapsulated and forms a tume faction in the joint.

At times in double fracture there often results, through carelessness, a synarthrosis or bony union of the two adjacent bones. Or there is excessive bone formation in fractures involving a joint and, through faulty surgery, a joint becomes ankylosed by bony, cartilaginous or fibrous union of the two or more bones forming the joint. Or, through rupture of the trophic nerve supplying a bone, the callus is very excessive in amount and slow both in formation and repair. Or, through poor immobilization, motion of the bone fragments upon each other causes excessive callus formation and large bone deposit.

A special characteristic of callus formation is that it tends to round up the fracture ends, whether the fragments have been well reduced or have suffered augular displace-

ment or are over riding. Similarly, bone splinters become embedded in the callus and obtain their blood supply through vessels of the callus, or of an attached bit of periosteum, and so repair. Or these bone splinters failing their nutrition die and undergo sequestration. Again, in the use of bone or ivory pegs used for immobilizing, there is first callus formation, then an absorption of the original peg-material, and a replacement by new bone. In bone transplantation of aseptic fresh bone or decalcified bone, there is first an imbedding by callus formation, then absorptian through new circulatory vessels, and finally new bone formation.

**Symptoms.** In most fractures there are *objective* symptoms of abnormal mobility, crepitation and deformity. The *subjective* symptoms are pain and functional disturbance. If the bone is grasped firmly both above and below the point of fracture there is frequently brought out the fact that the bone moves abnormally at some point within its length. Or, palpation over either fracture end may bring out mobility of the one fragment independent of movement of the other. At the same time, by moving one fragment upon the other, there is developed the feel or the sound of a crepitus or grating of the rough bone ends. At times if there is much displacement, especially over riding, muscle fascia or periosteum may intervene and interfere with crepitus. After reduction of the fragments, crepitus is uniformly to be gotten. Deformity is to be seen or felt, usually readily, and is a comparatively unimportant symptom, save as it may indicate injuries of soft parts or impress the laity. Pain is the all-important symptom, of use both in determining the point, direction and extent of fracture, and by its absence the determination of the proper reduction of the fracture. Pain is caused by the actual fracture, by the injury of soft parts, by hemorrhage into the soft

parts, and to a very small degree by the exudate at the point of fracture. Pain and muscular spasm conversely cause destruction of soft parts and more pain. Reduction and retention of fragments causes nearly all pain to cease.

With fracture there are uniformly *constitutional* symptoms. There is the fever of ferment intoxication beginning upon the first day and continuing two or three days, a temperature of 99.4° to 102° with slight headache and general indisposition, a pulse of 80 to 120 full and fairly strong, a coated tongue and constipation. Or there is a slight temperature rise due to autointoxication if the constipation is allowed to go on. Or there is, three or four days after fracture, a fever due to fat embolism of lungs or brain with its accompanying symptoms. Or upon the fourth or fifth day after a compound fracture there is a chill and a sharp rise in temperature to 101° to 103° and a quick bounding pulse, and sepsis has taken place. In any or all severe cases there is for a few days anorexia, pallor, a more or less nervous and sleepless condition, anxiety, and changes in the urine. Occasionally there is diminution or suppression, or there is polyurea or phosphaturea, or there is albumen and casts, an excess of urea, and during the first five or six days a considerable amount of liquid fat. There is reflex constipation.

**Complications** are many. There may be, especially in children, a considerable amount of shock. There is in severe injuries not infrequently traumatic delirium; and in the alcoholic, almost as a routine, delirium tremens. With compound fractures there is pretty uniformly infection. This may go on to gangrene of the soft parts in badly contused and comminuted cases; or there may be necrosis of the ends of the fragments; or infection of the bone ends and the beginning of a septic osteomyelitis. Fat embolism of the capillaries of the lungs and kidney may cause serious

complication and delay fracture repair ; or embolism of the brain causes death in three to four days. Or septic embolism of a vein may result in embolism of the pulmonary artery and death in 15 to 18 days. Or there is severe hemorrhage. Or there are the various constitutional anomalies of old age. Occasionally there is impacted fracture of an epiphysis and stunting of growth of the part.

**Diagnosis** of fracture is based largely upon the presence and the subsequent clearance of pain. We are further aided by palpation, inspection, by etherization if necessary, and often by measurement of the fracture and its symmetrical compliment.

**Prognosis** depends upon the severity and kind of fracture, its direction, the age and general condition of the patient, and the complications and the behavior of the fracture after reduction.

**Treatment** of fractures depends upon the particular injury and whether the injury is simple or compound ; to a certain extent upon the amount of shock as in children and old people ; upon the question of emergency ; upon the cleanliness of the patient ; and largely upon the patient's friends. Finally, treatment consists solely of reduction and retention.

A simple fracture is repaired by primary healing. The patient is put in bed if the fracture is severe or of a bone of the lower extremity. The clothing is carefully removed or ripped open or cut away. The friends are removed from the room in so far as is consistent with the necessary amount of assistance. If impromptu dressings and splints have been applied at the time of injury, they are pretty uniformally removed. The fracture is reduced by extension and counter extension, made if necessary by the assistant. The fracture ends are thus brought into allignment and position and maintained, and pain disappears,

Occasionally, due to muscular spasm, it is necessary to give an anesthetic in order to get the muscle relaxed not only sufficiently for reduction but for retention also. Once reduced the part is held in position and well padded with cotton and usually side splints applied. These are bandaged fairly snugly. If the part is bandaged too snugly and there is subsequent swelling, there is often pain sufficient to necessitate cutting down the splints and rebandaging the fracture. If the parts are not sufficiently and not evenly padded there will be pressure over the fracture or bone condyles, and this necessitates relief from pain. Basket splints in sufficient number to give the required thickness and rigidity are very useful. They can be cut in any length and bent to any shape by simple emersion in hot water for a minute or two. After the patient has now become quiet, pain and restlessness may still be sufficient to warrant the giving of a full dose of opium. This may be repeated especially during the night when these symptoms are worst. The limb is well elevated, either by suspension or by blocking up upon pillows. In the course of two days the patient will need a laxative, and the part will need to be cut down, examined and rebandaged. If there are serum blebs or blood blebs they are now opened and dressed aseptically. If the retention is good, and the parts decreased in size sufficiently, a plaster cast is applied upon the fifth to eighth day, to remain for a week or ten days. If the cast be put on too tightly there is danger of pressure-atrophy of the skin over bony prominences, and even of gangrene. Or if put on too loosely, or the swelling disappears very rapidly, or if there is marked atrophy of the muscles due to disuse, the cast must be cut down and another applied. After the cast has been applied, the patient is uniformly allowed to be dressed and about the room or house (except in hip, pelvis or spinal fracture), but for the

major part of the time keeping the fractured part well elevated. The diet, which upon the first few days was light or fluid, is now enlarged or made a full diet. So the patient goes on with or without a renewed cast, until the fracture is completely repaired and the patient is allowed to use the part, with or without bandaging or support.

Some fractures, as the shoulder, are retained in position best by a shoulder cap ; others, such as the arm, leg and thigh fractures, by the plaster of paris cast ; a few such as elbow, forearm and ankle fractures, by wooden or shellac splints ; a few by simple strapping and bandaging, such as Colles' fracture and broken collar bone. Fracture of the hip pelvis and spine demand special apparatus, extension and counter extension. Or in various circumstances, use is made of sand bags, the sand-box, and pulley and weight. Finally after each fracture is removed from its retention dressings there is a flushing of the skin, an active hyperemia followed by a passive congestion with pain and swelling. It is often necessary to use massage and alternate hot and cold spraying for one to two weeks to correct this condition. There is often functional disturbance from disuse of the part. This needs treatment by active and passive motion. If there are contractions, either reflex or permanent, they must be corrected by weights, by resistance, or by active motion, over extension, or by use of the part. In injuries involving the joint, the part must be exercised with great care before the fracture has fully calcified with the idea of preventing ankylosis of the joint.

Traumatic separation of an epiphysis is often difficult to retain till repair takes place. For this reason and to prevent possibility of no union whatever, it is often pegged or nailed to the diaphysis.

The length of time necessary for the repair of a simple fracture varies from two or two and a half weeks as in the

case of the clavicle to six or eight or ten weeks necessary for fracture of the hip or neck of the femur. The bones of the new-born repair almost instanter; the young repair fast; the old slowly or not at all, or only with fibrous union and a false joint.

**Compound fracture** may be divided for example and for convenience of treatment into: fresh fracture with perforation of the skin by a fragment; severe compound fracture; and fracture not fresh, but septic. Septic compound fracture must repair by secondary healing.

In the first class of *uncomplicated cases*, the fracture is reduced, the fresh wound is cleaned with a weak sublimate solution, a large sterile gauze dressing is applied and the limb put in retention splints or plaster of paris cast. The cast may be fenestrated to allow renewal of dressings, if required.

In *severe compound fracture*, multiple or comminuted, with laceration of the tissues, the treatment is largely antiseptic in character. If there are foreign bodies such as dirt, bone, splinters, clothing, or bullets in the wound, the wound is enlarged if necessary, and they are removed, and their track irrigated; spurting arteries are tied and farther oozing stopped by packing the wound with iodoform or aristol gauze; counter-drainage openings are made as required; the wound is dressed with antiseptic gauze, and retention splints applied. At times when the conditions of the wound are favorable, and there is no shock, a primary wiring or nailing of the fragments can be done; but great care has to be taken to prevent infection of the bone, thereby making the final condition worse than the primary one. In fact, as a rule, unless there are special reasons for operating, these compound fractures are allowed to repair without operative interference. At other times, especially in fractures at or near the epiphyses, the fractures are wired, pegged, or

nailed at once, as little traumatism as possible being done. Or with much overriding of the fragments a partial or full resection of the bone ends is done and the fragments nailed. The wound is then treated as a clean wound, closed, dressed, and a cast is applied for from one to six weeks. Or the compound fracture involves the joint, in which case it is treated as before. If later the joint becomes infected it has to be opened, irrigated, drained and dressed. At times there is union of bone and the deep tissues, but there is left behind a large granulating area. This has to be treated as such and Thiersch grafting done after full repair of the fracture.

In *fractures not fresh, and septic*, after one to three days we get a septic fever and an inflammation of skin edges around the wound and a discharge of thin sero-pus from the wound. This exudate gradually becomes purulent and the tissue and bone edges covered with boggy granulations. The wound is enlarged, drained, a dressing of wet sublimate gauze is applied, and the wound cared for until there is no temperature, the pus has disappeared, the granulations firm, and there is a beginning of callus formation and anchorage of the fragments. Or in other cases the wound becomes more septic, the tissues boggy and the temperature high. Here it may be necessary to amputate. Or gangrene begins in the wound.

The **after-treatment of fractures**, after their repair, consists largely in clearing up the ankylosis of joints and the atrophy of the muscles. The joints undergo fibrous cartilaginous and bony ankylosis during splinting of the fracture, and at the same time suffer certain functional disturbance ; and the muscles atrophy from disuse. Massage especially in the form of active and passive motion, or physiological exercise is necessary ; later, light gymnastic exercises ; and finally, after a week or two, full use of the member. The condition of passive congestion or hypostasis, of

the skin and subcutaneous tissues, is relieved by hot local baths and friction, and by bandaging and occasional elevation of the part. This, also, after a few days or weeks is cleared up. Local and general baths, alcohol rubs, local and general exercise, and a complimentary full diet completes the work. Occasionally nerve trunks are caught in the callus of repair. There often is pressure sufficient to cause severe neuralgia and to warrant cutting down upon the callus and clearing up the course of the nerve. Or the pressure is severe and paralyses and paralgesia result and a neurectomy is indicated, as for example in fracture at the middle third of the humerus with involvement of the musculospiral in the callus.

Or there is **delayed callus.** This is due either to imperfect immobilization of the fragments, to imperfect circulatory nutrition of the part, or to rupture of the trophic nerve. The fracture is perfectly immobilized. Or passive venous congestion is artificially produced by ligature well above the fracture point just sufficient to produce "warm" or "hot" congestion in the point. This is maintained for an hour or two, two or three times a day, until callus formation and bony union is complete. Or a neurorrhaphy or nerve-suturing is done.

Occasionally, through imperfect retention of fragments and delayed callus, the provisional callus goes on only to the point of forming a false joint, or *pseudo-arthrosis*, as in femur, humerus or tibia. Resort is then made to beating or hammering the fracture-area two or three times a day, or causing the patient to actively concuss the fracture ends by sparring or walking, thereby setting up inflammatory reaction in the callus and hastening bone formation. Failing this, there is resort to drilling the callus subcutaneously; or to operation, where the bone edges are freshened by the

knife chisel and curet, and the bone apposed and nailed. Or a complete resection is done.

In delayed bone union through secondary repair of compound fractures, with or without death of the bone ends, there is often necessary such a resection of bone substance as to cause considerable shortening and necessitate a *transplantation of bone.* For such transplantation, use is made of dog's bone with or without its nutrient blood supply, of human bone fresh or devitalized, and of purely calcareous bone. In most of these operations there has been practically a uniform failure. Far better results have been obtained by retaining the periosteum of the old bone fragments, channelling out necrosed bone and allowing repair to take place by bone granulation.

**Treatment of deformities** of bone or of joints following fracture repair, if sufficient to cause serious disturbance of function, is to remedy them by operation under an anesthetic. The bone is refractured subcutaneously by certain appliances as osteoclasts, or by manual manipulation ; the bone fragments are again brought into normal position ; retention splints or cast are applied and repair allowed to take place. Or the bone is cut down upon aseptically, the periosteum is separated from the bone and pushed back, and the bone fractured by means of a bone chisel, or osteotome, and lead mallet. The bone is then brought into the desired allignment, the flesh wound is closed, sutured and dressed aseptically, and the part placed in a plaster cast for three to five weeks, when there is uniformly perfect union and repair. This is also the usual treatment of knock-knees and bow-legs.

In the case of *ankylosis* of joints following fracture, the adhesions are broken up by forcible manipulation of the joint under an anesthetic, and the joint is placed in a retention splint capable of ready removal at any time. After the inflammation and swelling due to the manipulation of the

joint has partially subsided, active or passive motion of the joint is kept up from day to day, and the joint surfaces rounded up partly through degeneration and partly from regeneration changes in the bony framework.

**Change of dressings** in compound fracture, or fracture compounded through operation, is made according to the rule that dressings should be changed too often rather than too seldom, should there be danger of sepsis; or in sepsis, should there be accumulation of exudate or lack of free drainage.

## CONTUSION AND WOUNDS OF BONE.

**Contusion of bone,** constitutes a disruption of the bone-parts without destruction or break either in the periosteum or the skin-covering.

In the simplest traumatism of bone, the blow is sufficient only to cause a *bruise.* In this there is some disturbance of the periosteal circulation, with pain, swelling and some slight serous exudate underneath the periosteum.

Or there is produced a rupture of the capillaries at the point of injury and *periosteal hematoma* is formed beneath the periosteum, stripping up the periosteum from the bone and causing rather severe throbbing pain, some swelling, redness, pain on pressure and more or less functional disturbance. These injuries repair by absorption of the exudate; or there is a chronic change, a productive periostitis, and local ossification at the point of injury. Repair is hastened and abetted by bandaging, the application of an ice bag and elevation of the part.

Or there is *compression* or depression of the bony envelope underlying the periosteum with blood extravasations

into the medullary tissue. The symptoms are pain and tenderness on pressure ; perhaps slight indentation of the bone ; slight superficial swelling ; and deep often intense throbbing pain, due to the internal pressure of the extravasation and exudate, that may localize at the point of injury, or radiate throughout the bone, or be referred to a nearby joint. In injuries of this class there is little chance for infection, or they may rarely go on to the formation of pus, or set up an acute osteomyelitis, or be indirectly the cause of tubercular disease of the bone. The treatment is much the same as that of bone bruises ; applications of continuous cold, elevation of the part, and occasionally bandaging. But the pressure and the pain is greater, and the patient will need opium ; the repair takes a much longer time, one to two weeks, and elevation of the part and the enforced quiet is to be insisted upon though it is very irksome to the patient. Late in repair, massage is of considerable use.

A **wound of bone** constitutes a partial solution of continuity of the periosteum and the bone, as well as a disruption of skin and other overlying soft parts. Such wounds of bone are therefore open wounds and liable to be infected. These open wounds are caused by knife and axe cuts, saber or sword cuts and thrusts, and dagger cuts. They are cared for by cleaning out the bone injury and stauching the bleeding by applications of hot water and iodoform, suturing the divided periosteum and closing the skin and overlying parts by sutures. The superficial dressing is that of an ordinary operation wound. At times these wounds are septic and one or two sutures have to be removed to effect drainage. Otherwise, the wounds are treated by the open method of secondary healing and allowed to heal by granulation and with the formation of ugly scars.

## INFLAMMATION OF BONE, OSTEITIS.

**Osteitis**, or simple inflammation of bone, is either a condition associated with periostitis and osteomyelitis, or stands alone as a disease by itself. It is more or less chronic in character due to the formation of productive tissue bone-cells. This may be in the form of **carnous osteitis** due to bony granulation tissue of low vitality, and is usually of tubercular character. Or it may constitute **osteosclerosis**, with increase in density of the bony envelope at the expense of the new or the old cancellous tissue cells. Another form of osteitis is **osteoporosis** in which the compact bone undergoes degeneration and in its place is repair tissue of granulation tissue type or cancellous tissue. This form is also known as **rarifying osteitis.** It leaves the bone tissue very fragile and subject to fracture. **Syphilitic** or **gummatous osteitis** is a rarifying osteitis of the outer or inner part of the diaphysis, rarely of the epiphysis. It is filled with the peculiar gummatous caseation tissue and occurs largely in the tibia, sternum and ribs. **Suppurative osteitis** may be a periostitis or osteomyelitis and results in bone ulcer or **caries**; or in bone death or **necrosis**. An **osteophyte**, or **exostosis**, usually follows a suppurative bone lesion and is an attempt of the tissue at some point to repair. The growth is abnormal both in position and in amount and usually takes place beneath the periosteum or some preexisting bone surface. Bony **ankylosis** is an exostosis in a joint cavity causing fixation of the joint through exostotic union of the bones constituting the joint. **Osteoma** is a large exostosis or bone tumor. It may be very large, or small; it is usually hard and consists of compact bone-tissue, or it may be soft and made up of cancellous tissue.

Acute osteitis is either simple or suppurative.

**Acute simple osteitis** is a disease, the distinction of which is of little importance as it verges on the one hand into periostitis or into osteomyelitis on the other. Due to traumatism, there is pain that is throbbing, deep in the part, and much worse at night. There is some superficial swelling of the tissues, perhaps sugillation, and that is all. The pain is worse on pressure or when the part is not kept elevated. Treatment,—elevation and cold. If there is danger of extension to the medullary cavity, or osteomyelitis, the inflammatory site should be opened to effect drainage.

**Suppurative osteitis** follows open wounds of bones, that are infected ; or it takes the form of suppurative or infectious osteomyelitis of children and will be discussed under that head.

## PERIOSTITIS.

**Periostitis** is an inflammation of the periosteum or outer osteogenetic membrane of the bone. It is either a disease by itself or more usually is a condition associated with an osteomyelitis of purulent or tubercular type. It is both acute and chronic. The acute forms may be simple, hemorrhagic, diffuse, or suppurative ; the chronic form assumes the type of osteo-periostitis, an inflammation of both membrane and bone, and causes productive bone tissue in the form of osteophytes or exostoses.

**Acute traumatic periostitis** is simple or hemorrhagic, diffuse or suppurative, depending upon the sequence of events, the extent and character of the injury, and the care and treatment of the inflammation. The causes of perios-

titis are largely traumatic such as wounds and blows, or is the result of adjacent inflammation such as ulcers, tuberculosis, syphilis, or infection, or it follows cellulitis or the infectious fevers. The *mild* forms result in simple serous exudate thrown out in small quantities beneath the periosteum and cause little or no subsequent symptoms save slight pain and soreness. Probably in this category may fall the "shin fever" of persons unaccustomed to walking and who attempt long and rapid tramps or hill climbing ; caused by the strain of the leg-fasciae pulling upon the subcutaneous periosteum of the tibia. If these exercises are continued, as in the forced marches of soldiery, there are caused subnodular thickenings of the anterior border of the tibia. Or the exudate may be diffuse or hemorrhagic or become infected. The *severe* cases are those of considerable pressure of the exudate, especially of the suppurative type. They require general antiphlogistics, well carried out ; and if septic, incision and drainage. They cause little subsequent damage to the parts, but occasionally may become chronic.

**Chronic periostitis** consists largely in a productive inflammation or a reactive new formation of bone. The causes are preceding acute periostitis especially the suppurative type, or long continued irritation of the bone. There is most usually either an extensive dense *fibrous thickening of the periosteum ;* or there is *new formation of bone*, an ossifying periostitis, with or without a superficial caries. It seldom occurs alone, is usually associated with osteomyelitis in the tubercular syphititic and suppurative bone inflammations, and is treated along general lines.

**Ossifying periostitis** is local or general ; there are circumscribed patches of new bone formation, osteophytes ; or there are diffuse or general changes, perhaps involving the whole of a bone shaft. This latter condition is known

as hyperostosis. The treatment is at first tentative, followed, when no longer tolerable by the patient, by incision and the free use of mallet and chisel.

Or there is *chronic suppurative periostitis* a sequence of acute suppuration of the periosteum or the medullary cavity. The treatment is to incise, curet, pack and allow the wound to heal by granulation.

## OSTEOMYELITIS. OSTEOCHONDRITIS.

**Osteomyelitis** is an acute suppurative inflammation of the cancellous tissue of the diaphysis; only occasionally is there a simple exudative inflammation. The tissue is very vascular, without fat, encloses red marrow, and communicates by many vascular channels with the periosteum and the medullary cavity. The blood circulates in this tissue without vessel walls. The epiphyseal cartilage blends with the periosteum and closes off communication with the epiphysis. Bone growth is largely upon the diaphyseal side of the cartilage and it is here that the inflammation largely originates.

**Lesion.** One or more points of infection begin to set up active hyperemia ranged along the diaphyseal side of the epiphyseal cartilage. In adults, in the long bones, this vascular structure has ceased to be red marrow, and the new foci stand out red against the yellow background. In youth these foci are a light red against the darker red of the vascularized cancellous tissue. As the inflammation proceeds, granulation tissue is formed with exudate of both red blood cells and white blood cells. This invades the whole end of the diaphysis; it extends to the medullary cavity, degenerating its fat and replacing it by granulation tissue; and often

passes through the vascular channels to periosteum, stripping up that membrane, and by blocking off the blood supply causes death of bone, or necrosis, total or partial. The process is preeminently a septic one and is due to direct infection, infection by extension from neighboring tissues as an open wonnd, or it is hematogenous or brought from some distant point in the blood current. The lesion is usually well along in its development before the disease is recognized. It is often miscalled rheumatism.

**Causes** of osteomyelitis are the staphylococci and streptococcus pyogenes. Following typhoid and the exanthemes, pyemia and septicemia, and occasionally pneumonia, there are not infrequently primary foci of mixed pus cocei that cause at times secondary foci in the bone ends. Otherwise the infection is brought largely through wounds directly to the bone tissues. Or there is only a history of a bruise, kick or sprained leg, or an exposure for a long time to wet and cold.

The **course** is mild or severe, or in children follows the type of an acute infectious disease and involves many bones. Typically it occurs in the shafts of the tibia and femur next the knee. If the course is *mild*, there is formed at one end of a single bone a localized bone abscess, that continues to enlarge through a process of degeneration or rarifying osteitis, and at some point breaks through the bony envelope and forms a fistulous tract, discharging its purulent contents upon the skin surface, and leaving behind caries of the end of the bone. This carious bone is liable to fracture and is certain to keep up pus formation and continuous or intermittent discharge through its fistulous tract. Or there is an attempt of the carious bone to repair through granulation. The fistula may make a direct exit to skin surface, or more probably it will follow gravity drainage and appear at some dependent point far away from

the original bone opening. In this case, the fistula lies deep along the bone and is simple ; or it saculates and forms large pus pockets, stripping up fascia muscle and tendons.

Or the disease runs a *severe* course. The inflammation instead of being localized, invades the whole of the shaft of the bone, the medullary canal is filled with red granulations, pus and fat globules ; the inflammatory products, through pressure, invade the vascular channels and there is extension of the inflammation under the whole periosteum stripping it from the bone. The bone dies and necrosis results. Finally there is sufficient pressure at some one point or several points to cause the formation of fistula. The abscess cavity is relieved for a time until the fistulae block up and they are obliged to open again or new fistulae form. Or there is extension out into the soft parts and invasion of the joint ; mild sero-fibrinous, or a septic arthritis. Less often, the epiphyseal cartilage undergoes erosion of its bone substance and there is infection of the joint by direct extension. Or, occasionally, infection of the joint and the neighboring bone is through an infected anastomotic circulation ; this is rather true of the third class, the infectious cases in children and the pyemic cases of adults, where the extension is rapid and the cases uniformly fatal through general sepsis.

Or there is in children, especially, an *acute infectious osteomyelitis* which may begin in one bone, such as tibia or femur and become rapidly multiple, involving many bones. Or it may in addition by metastasis give rise to inflammation in bones at some considerable distance away. These bones in which the secondary and metastatic infection takes place are usually the clavicle, scapula and the innominate. Caries and necrosis follow, or there is death from general sepsis or pyemia. This type runs a regular infectious

course and kills the patient or leaves him invalided or crippled for life.

Symptoms of the *mild* cases are those that regularly accompany the formation of a small or a large bone abscess. Both the local and constitutional symptoms are slight ; and yet the symptoms are not always in accord with the amount of the destructive lesion, but rather correspond with the sharpness and virulence of the inflammation. A child gets a simple bruise, as in football, that passes almost unnoticed during the play. After a day or two he begins to have a temperature and headache, and feels sick. There may be a chill. The bone or the neighboring knee joint becomes red and inflamed and simulates rheumatism. There is steady grinding pain or throbbing in the parts. On examination, mainly through palpation, the focus of inflammation is located in the upper end of the tibia or lower end of the femur. In a certain few of the cases, by elevation, cold, bandaging and saline catharsis, the disease stops here. In the majority, however, the local symptoms become more marked and the general constitutional symptoms are those of sepsis. If the abscess breaks through the bony wall, or is trephined and opened, all the symptoms subside.

In the *severe* cases there is a sudden invasion preceded by a well-marked chill, or the invasion is mild but gradual. Soon there is marked local tenderness, with intense pain and throbbing. The temperature is high, the pulse rapid and bounding, there is headache, restlessness, often wild delirium. The symptoms may even be grave in exceptional cases and the constitutional disturbance so severe as to cause death in a very few days. Usually however there is an increase in the severity of the symptoms until the pressure of the exudate is relieved by fistulous opening and discharge of the abscess contents. Then the symptoms disappear rapidly and at some future time the patient consults a

surgeon to know if he cannot be rid of his fistulous openings and the constant or recurring discharge. And the surgeon by probing the fistula finds necrosed bone.

Or there is remission of symptoms with invasion of the neighboring joint, especially if there is invasion of its contiguous bone. In indirect fistulae, pus pockets may cause minor septic temperatures and general disturbance, as may also the blocking up of the discharging fistulae.

In the *acute infectious* cases of children the invasion is most marked. There is a chill, or vomiting and anorexia. The temperature rises quickly and high; the pulse is at first bounding, then very rapid and very feeble; there is marked restlessness and pain, and later delirium.

Or the child is pale and looks worn out, lying quietly with dry skin, coated tongue, feeble soft pulse, giving sharp cries of pain on movement or upon the slightest pressure. The temperature is not very high. Many joints are reddened and swollen, and purulent. There is an aspect of intense suffering.

Or the child is first seen in a comatose condition.

**Diagnosis** is made by means of the history, and by palpation over the diaphyseal ends. Many of the mild cases are wrongly diagnosed periostitis and osteitis; many of the severe cases, rheumatism; and many of the acute infectious cases, rheumatism, typhoid, septicemia and pyemia. These cases are acute, and are to be differentiated from the tuberculosis of bone which are chronic and seldom if ever fulminant. Early diagnosis must be made to save life and limb.

**Prognosis** under early and correct diagnosis and with prompt surgical procedure is good, except in the rapidly fatal cases. Until recent years the disease has been little understood and its gravity little appreciated. All damage was

done before a diagnosis was made. The disease terminates uniformly in suppuration.

**Treatment** in all cases, perhaps, consists in the immediate and thorough use of chisel and mallet and curet. The wound is drained, packed and allowed to granulate. If a whole shaft is involved, the bone should be guttered with the gouge till nothing but sound tissue is left behind. If joints are involved, they shouldbe incised, cleared out and drained. Carious bone should be curetted, all necrosed bone cut away, and all fistulous tracts carefully cleared up. In cases of large destruction of bone-tissue, use is made of Senn's bone chips or Schede's aseptic blood clot to hasten repair. Even if not fully successful they are of material use in shortening the time needed for bone granulation. Or the abscesses or bone gutters are packed loosely with iodoform gauze, that stimulates and hastens repair. The limb must be kept elevated in the severer cases for a period of one to two months before repair is complete. The limb is best kept upon a removable splint that dressings may be the better applied and the limb immobilized. If the wound is all cleared of fistulous material, necrotic, carious and granulating tissue and still does not repair, but undergoes retrograde changes after a month's careful treatment, the inflammation is probably a tubercular one and is uniformly fatal through extension and sepsis.

According to the various classifications used, there are two forms of productive inflammation-results in osteomyelitis ; the sclerotic and the rarifying, or osteosclerosis and osteoporosis.

*Spontaneous Separation of the Epiphysis* occurs at 14 to 20 years and is usually secondary to suppurative periostitis,

osteomyelitis or arthritis. It is to be treated as simple or as compound fracture according to circumstances. It repairs invariably with shortening.

**Osteochondritis** follows the same type of lesion as osteomyelitis. As the cartileges are largely articular, the resulting productive lesions such as exostoses and osteophytes aid in the formation of ankylosis, and the cartilage is rendered atrophic, fibrous, non-resiliant and functionless.

## NECROSIS. INVOLUCRUM. SEQUESTRUM. PHOSPHORUS NECROSIS.

**Necrosis** is death of bone in mass. It is due to traumatism with disturbance of circulation of the periosteum, or it follows denudation of periosteum in fracture of a bone. It follows venous congestion as in suppurative periostitis, or conversely it is due to embolus or to the obstruction of the Haversian canals in osteomyelitis. Or it may be due to trophic changes in a part.

Necrosis usually follows, of bone diseases, osteomyelitis and tuberculosis of bone. The form following suppurative periostitis is a partial necrosis, if at all probable.

**Anatomical changes.** As soon as circulation has ceased in the bone, necrosis takes place, partially or totally. There is a separation from its periosteal blood supply and there is a complimentary attempt upon the part of the sound bone to cast off the necrotic portion. As in soft parts a line of degeneration, or of *demarkation*, forms. Osterclasts form and liquify bone salts at this point and

gradually free the dead fragment, which now forms a *sequestrum*. If the necrotic fragment is centrally placed within sound bone, this process of sequestration is said to take place by a process of, or in connection with a process of, rarifying osteitis whose special characteristic is its very rough interior while the exterior of the bone surfaces is perfectly smooth. Around the sequestrum, due in part to the original inflammation and in part to the rarifying of the bone, is a mess of pus and detritus in which the sequestrum swims or floats. There is soon an outlet of this fluid material through fistulous openings, when the tissues tend to take on a process of regeneration. The periosteum begins to form new bone tissue. This is larger than the original necrosed area and continues to grow still larger ; it is not as thick as the original bone but is of compactly laid bone. It constitutes the *involucrum* and surrounds the sequestrated necrotic bone, and between them is usually a not inconsiderable amount of pus.

Or such necrosis may be partial and be termed superficial or external or peripheral ; or it may be central, lying totally within the shaft of the bone ; or be total ; or be both partial and multiple.

**Symptoms and diagnosis** of necrosis are those of recurring or constant purulent discharge from a fistulous track leading down to inflamed bone. Occasionally small bone splinters work out the fistulous openings and the pus, at least early, contains the fat of the broken down marrow. Upon inserting an exploring probe through the fistulous track to the inflamed area, the movable sequestrum gives, under the touch, the feel of slightly roughened dry bone, while the enclosing shell caused by the rarifying osteitis feels rough and non-resisting ; or the new involucrum feels especially hard, glassy and usually smooth, and if tapped gives out a slightly hollow, or cavernous, or tympanitic

sound. Sequestra are greyish-white in color and if smooth indicate that the necrosis is from the surface ; if rough, the necrosis is of central origin. A soft sequestrum is indicative of tubercular necrosis.

**Treatment** consists of opening down to necrotic bone and completing sequestration if necessary by operative measures. All parts of the fistulae are thoroughly eradicated and their edges cleared of any bits of questionable tissue. All rough parts and angles of the enclosing bone, whether it consists of old or of new bone tissue, are thoroughly chiseled and scraped, and all precautions for care and cleanliness are observed. The wound is then allowed to repair by granulation, or by means of Senn's bone chips, or through closure of the tissues over a contained blood clot that is aseptic. The treatment is radical and thorough and the results good. The earlier operative interference is begun in necrosis, the better are the results and the more is the sound bone saved.

**Phosphorus necrosis** is an inflammation peculiar among phosphorus workers or match-makers, probably due to their inhalation of the fumes. This inhalation causes periostitis, osteophytosis and at times total necrosis of the mandible. The disease attacks occasionally the bones of the face and the maxilla as well, but does not cause so great a destructive lesion there.

**Lesion.** The disease begins with some slight salivation and irritation of the gums. There is apt to be pericementitis, especially around carious teeth. Soon the periosteum is invaded, and gradually the body of the bone. There is abscess, caries, partial necrosis, osteoporosis, osteophytosis and occasionally osteosclerosis, and so continues to total necrosis in about three years unless the original focus is eradicated.

**Symptoms** are those of similar bone inflammations.

**Prognosis** is good if treated early.

**Treatment.** Prophylaxis has done much ; chemistry has substituted the innoxious red oxide in the making of phosphorus matches, where formerly state legislation interdited negligence in match manufacture. Small foci are early eradicated. Late in total necrosis, the sequestrum has been removed with total repair of the bone, the bone regenerating if only a periosteal sack can be saved. Alkaline and turpentine mouth washes used locally neutralize the phosphorus.

The disease is now rare.

## CARIES.

**Caries** is bone ulcer, the result of previous purulent inflammation with subsequent infiltration of granulation tissue. It rises from suppurative periostitis and osteomyelitis, but is more often tubercular in origin. It is variously known under the name of osteohelcosis, bone ulcer ; or osteosapria, or softening of bone. In all cases it rises from abscess, whether from excessive exudate formation as in suppurative periostitis ; or from, or as a result of, a rarifying osteitis when the abscess lies within the bone ; or from granular or caseous degeneration of the tubercle, aided by mixed infection of the bone.

**Lesion.** Caries follows degeneration of bone, or osteoporosis, and is the effort of the bone cells to reconstruct the broken down tissue. After the bone abscess has in part discharged its purulent contents, the bone attempts by secondary repair, or granulation tissue, to rebuild. As in

secondary repair in soft parts, so here, the granulation tissue, consisting of a more or less fibrous framework and its aggregation of round cells, attempts to build up sound osteoid tissue about the abscess walls, and at the surface is bathed in purulent serum. In part this repair is successful; repair bone, or osteosclerotic bone hard and compact, is laid down at one point, while, due to the inefficient drainage of the purulent products through a narrow fistula, the degenerative changes of osteoporosis is going on at another point. Enlarge the fistulous opening and establish efficient drainage; degeneration ceases and repair begins at once; the abscess, now an ulcer, is speedily built up by granulation tissue; and the caries, formerly of so-called moist type, now becomes a dry one.

In caries of the vertebral bodies of tubercular origin in children, the beginnings of the disease is in the form of a tubercular periostitis or osteomyelitis near the periosteum and the intervertebral discs; in other words where the bone growth is greatest. The resultant caries lies along the anterior surface of the bone, largely, and beneath the resisting anterior longitudinal ligament. There is production of granulation tissue, and absorption of the bone, and pus; the ligament is stripped off the front of the carious bodies; and the pus by gravity drainage follows lower and lower down the spinal column beneath the ligament until it finds egress beneath the iliac fascia and finally has its exit in the groin as a psoas abscess. Or the caries is of the lateral aspect of the vertebral bodies, follows down between the layers of the lumbar fascia and appears upon the abdomen between fascial sheaths as a large cold (chronic) abscess.

**Symptoms.** Osteoporosis causes erosion of the cancellous tissue and leaves at times only a shell of outer bone, subject at any time to crushing and fracture. Probably most cases of separation of the epiphyses following a bone

inflammation are due to this cause. Osteomyelitis, and its resulting caries, causes tenderness at the point of attack, that is constant or that is marked on pressure or concussion. As the erosion of bone goes on, the tissues, subject to supporting body-pressure such as vertebral bodies and the acetabulum, give way under the pressure and deformities result. The spine is doubled upon itself, forward or laterally or at an angle; the acetabulum loses it cupped rim and a gradual dislocation and malformation of the hip results. At this stage these malformations may be corrected, since natural drainage by fistula has relieved the carious cavity of its pus pressure and irritation by this time, and reparative changes with ankylosis begin shortly.

The general constitutional symptoms are as bad as possible. The patient is tubercular. He is pale, anemic, thin; there is loss of appetite, flesh, strength and moral tone. He is at once discouraged and discouraging.

**Treatment** is that of the original disease. The lesion constitutes a rough irregular cavity of one or more bones partially or wholly filled with dark and shaky granulation tissue. This is to be removed by chisel and curet, and drainage established. All bone-pockets must be broken down into the general cavity.

Frequently the sequestra of necrosis are found associated in this erosion process of caries, and are found in the debris of an abscess cavity. Conversely, the cavity of a necrotic abscess constitutes a caries, especially when the reparative process is slow or nil, and osteoporosis is present at the same time.

## BONE TUBERCULOSIS.

**Tuberculosis of bone,** or tubercular osteomyelitis, is primary in the bones of the vertebral column and of the wrists and ankle. It is a secondary inflammation when it occurs in tendon sheaths, synovial membrane and the bursa. It was a condition formerly associated with tubercular skin and glandular enlargements under the elastic misnomer, scrofula.

**Lesion.** Small yellowish or grey-red, millet-sized and circumscribed foci, containing the miliary tubercle, appear in the periosteum, the epiphyses, the medullary cavity or in spongy bone. These foci remain inactive, or, after some traumatism or devitalization of the part and especially after an added pus-coccus infection, they begin to enlarge and coalesce. Lacunar absorption takes place in the adjacent sound bone ; the tubercle, shut off now from its circulatory supply, undergoes caseation and forms a sequestrum surrounded by pus, with or without fistulae. Or there is a reactive inflammation and the tubercle becomes encased in hard bone. Or there are formed long fistulous drainage tracts leading to cold abscesses located at a distant point ; the pus being contained within a so-called pyogenic membrane that is made up of fibrous connective tissue and tubercular granulation tissue containing the tubercle.

Tuberculosis of the bodies of the spinal vertebrae is followed by spinal curvature and lateral displacement ; of joints and joint surfaces, by subluxations and dislocations ; in the orbital floor by abscess and necrosis ; and in the carpus and tarsus, by involvement of bone, synovia, sheaths and joints, with enlargements, angular deformity and ankylosis.

**Causes and symptoms.** The disease is very chronic. The symptoms appear only after months, Children and youth are mainly affected ; and the disease is not common

in adult life except as the result of some concurrent injury, as of the wrist or ankle. At first there is some swelling of the periosteum, loss of function in the part, some pain, and perhaps some slight tumefaction, but without redness, localized heat or special inconvenience to the patient. The inflammation progresses very slowly but gradually. The symptoms become worse or aggravated, and there is pus formation, then fistulae, and finally painless tumefaction by the formation of cold abscess at some dependent point.

Or much later, osteophytes are formed and cause much pressure-pain by displacement of the fascial tissues.

Or there is much swelling, pain and redness due to an active tubercular osteomyelitis.

Or as in tubercular hip joint, the onset may have all the characteristics of rheumatism or typhoid fever. The pains are referred to the knee joint and that joint is carefully cared for; and it is only by pressure over the trochanter of the femur that the site of the disease is established, or in late cases it is determined only by the marked shortening, deformity and limited action of the hip.

Or as in the case of tubercular synovia of wrist or ankle, the inflammation extends, without discomfort to the patient for years perhaps, and then due to painful swelling and functional disorders the patient comes for advice; or waits till the various tissues have become entirely invaded and eroded, carious fistulae present, and perhaps septicemia established.

Uniformly as a rule the onset of tubercular osteomyelitis is more or less abrupt and is ushered in by a fever of greater or less intensity. At the time of this fever or only after its subsidence does the active inflammation begin.

**Diagnosis** is made, through experience, by means of the localization of the inflammation in certain situations in certain bones and joints,—points of predilection,—and by

the symptoms and uniformly slow course of the disease as compared with purulent osteomyelitis. On the other hand bone-syphilis is chronic, occurs in late syphilis, prefers the tibia, sternum, ribs and cartilages, and chooses, at an early period of its development, not cancellous or spongy bone but the hollow diaphyses. Syphilis attacks periosteum more often perhaps than the medullary membrane.

**Prognosis** is serious, if not bad. Caries of the vertebral bodies, if taken in hand early, after treatment for two or three years, ceases any active process. Tubercular osteomyelitis of bone shafts if cleared up early ceases to be active. The inflammations of joints and synovia are evidently seemingly recovered from, after operative interference. But sooner or later there is prone to be recurrence.

**Treatment** is that of simple acute osteomyelitis, the curet and chisel, plus absolute rest of the parts by fixation splints and orthopedic appliances, and especial care as to hygiene, diet and climate.

## RACHITIS. OSTEOMALACHIA. SCURVY.

**Rachitis,** or rickets, is a constitutional disease of childhood, characterized by impaired nutrition, by formation of bone that is deficient in lime salts, and by an increased absorption of the fully formed bone. The disease occurs in the first few years and seldom after the age of six. It is caused by underfed nursing mothers ; by unbalanced ration in the artifically fed infant, such as the exclusive use of condensed milk ; and especially by a food deficient in alkaline and calcareous salts. There is usually diarrheal disturbances.

**Lesion,** in the bone, consists of chronic inflammatory changes whereby there is an abnormal development of the vascular loops at the epiphyseal cartilage, a consequent hyperemia, and a very rapid formation of new bone tissue, but without a corresponding calcium-salt deposit. At the same time, the osteoclasts by means of carbonic acid formation are setting up lacunar absorption in the old bone. The result is bone in which there is often only about a quarter of the normal quantity of calcium salts, that remains for years in this uncalcified condition, and that is abnormally soft and is easily bent. In normal bone at this period there is a well-marked groove at the epiphyseal juncture, but which is absent in the rachitic. Not until the child is old enough to be table fed does the disease disappear, through lime-salt deposit in the bones. Then we find bow-legs, knock-knees, club-feet, pigeon-chest, flat-foot, angular deformities at diaphyseal ends, enlarged epiphyses and loose movable joints. These children are able to walk and talk late. Dentition is late or irregular and painful. The pelvis is often contracted and the spine curved. The children are small and stunted, or generally malformed. Due in part to the diet, there is pot-belly with flabby abdominal walls. There is constant intestinal irritation with diarrhea, or alternating constipation, and atony of the gut. The lymph nodes and the mesenteric glands are regularly enlarged, and there is frequently enlargement of the spleen and liver. There are frequent attacks of naso-pharyngitis, choryza, bronchitis and pneumonia.

**Course.** These children die early and rapidly in the summer months unless the food is balanced. The malnutrition gets progressively worse and the babies die of starvation and of prostration from the diarrhea. Or they die, soon after birth, of inanition. Or after two years, the

disease is more chronic and the little patients survive by providence.

**Symptoms** are mainly those of indigestion,—diarrhea or constipation,—and of malnutrition and deformity. These children look thin, drawn, hollow-eyed, weazen and old, if disease is at all chronic. They are peevish and fretful.

**Diagnosis** is to be made between scurvy, rickets, general tuberculosis and inherited syphilis. The deformities easily distinguish it. The indigestion and malnutrition are its most marked symptoms.

**Prognosis** is decidedly good, at all times short of inanition, with proper food and hygiene.

**Treatment.** Stop the infant's feeding and give a purely starch diet for a few days until intestinal fermentation has ceased. Irrigate the gut with normal saline twice a day. Then give a mixed ration of pasteurized cow's milk and oatmeal gruel slightly sweetened and salted, in varying proportion depending upon the age of the child and the state of its digestion. Later, increase the amount of fats by additions of top-milk and cream. In infants a year old begin the meat juices regularly, gelatines, egg albumen, and starch foods in the form of cereals, crusted bread and zwieback. Finally, after two years, make the diet broad and rational. No medicines save possibly cod liver oil feeding and tonic stimulants. Send the patient to a farm in the country or to the seashore.

The deformities are corrected spontaneously or, late, by the aid of splinting. Or osteotomy or osteoclasis is performed and the parts put in plaster of paris casts for six weeks.

**Osteomalachia** is a disease of adults, particularly pregnant women, simulating rickets. It probably due to changes of malnutrition; there is absorption of the bone,

and bone-softening and deformities, especially contraction of the pelvis. The cause is unknown.

**Lesion.** There is absorption of lime salts, gradually progressing from periphery to center of the bones, until only a mere shell is at times left behind. There is hyperemia of the medulla and lack of marrow-fat. The pelvis is often much contracted. Other bones may be affected as vertebrae and ribs, rarely the long bones, and the flat cranial bones. The disease is probably due to poor foods and bad hygiene, causing poor assimilation and a deficiency of lime salts.

The **symptoms** are those of pain in the affected bone, simulating rheumatism.

**Prognosis** is bad. Cures are spontaneous.

**Treatment.** Stop child-bearing. Hysterectomy. Oophorectomy. Otherwise as rachitis.

**Scurvy,** another disease of malnutrition, is characterized by changes in the walls of the blood vessels, causing swelling and hemorrhages into the mucous membrane of gums, mouth and lips and the formation of granulating and bleeding ulcers there. Hemorrhages take place also into the skin and subcutaneous cellular tissue, the muscles, joints and intestine. There follows or is associated general emaciation and anemia. There are often painful muscular contractions. It is caused by a poor diet and limited rations, such as salt pork without vegetables. The treatment is fresh meat and vegetables and the citric fruit-acids such as lime and lemon.

Scurvy is a disease of arctic expeditions and prison-privation and is rare.

## ATROPHY AND HYPERTROPHY OF BONE.

**Atrophy of bone** is due to a multiplicity of causes, usually defective nutrition, circulation or enervation. There are changes in dimension and in the strength of the bone. Such changes are temporary or permanent; or may be infantile or senile; they may occur as pathological changes or are due to purely natural causes. Osteomalachia causes bone absorption from without inward, osteoporosis from within outward; both thinning the bone walls. Disease or injury at the epiphyseal cartilages often interrupts diaphyseal growth and affects atrophy. Interuterine constrictions cause atrophy of a whole upper or lower extremity, as does infantile paralyses. They constitute trophic disturbance. There is occasional atrophy of disuse following constricting casts in the young, or as seen in the atrophy of the femoral head following old dislocations, or as in the normal absorption of the provisional callus when no longer needed for use. Constant pressure causes atrophy, as seen in some occupations. In senile osteoporosis there is atrophy of the femoral neck, functional impairment, and liability to fracture. Atrophy is seen in acromicria, nanism and dwarfism.

**Hypertrophy** of bone is local or general, and is caused by a variety of normal or diseased conditions. The normal, acquired, hypertrophy is familiar in the bony ridges of bone due to muscle pull, the lengthening of bone by process of weight carrying, the enlargement of condyles due to intermittent yet constant use or joint trauma, and the enlargement of general stature due to free living and full exercise. Congenital hypertrophy is exampled by the various deformities such as giant growths, leontiasis, acromegaly, and giantism. Periostitis and osteomyelitis give bone hy-

pertrophies in the form of exostoses, hyperostoses or the more general condition of osteosclerosis. Motion in a provisional callus, or cutting its trophic nerve, or artificial hyperemia causes an increase in callus and in the reparative formation of bone. This hypertrophy is the effort of the bone-cell to supply the needs demanded of it, and causes increase in structure and in strength of structure.

## GUNSHOT INJURIES.

**Gunshot injuries** vary according to the weapon, powder, range, and the kind of shot used. Shot varies from "dust" and "mustard-seed" to that of heavy ordinance of 12, 16 and 20 inches diameter.

Near range and *fine shot* may burn the skin and leave a large track ; at medium range they simply imbed in the tissue, especially in fascia ; at long range, and spent, they cause surface bruises or tingling welts.

Near range with *rifles or revolvers of small* (22) *caliber* gives burning of clothing and skin with or without penetration, or deflection or lodgement ; middle range uniformly gives perforation, or penetration that is shallow, lodgement and infection of its track ; long range may just perforate, or leave ragged wounds, or welt the surface only.

*Rifles of large caliber* (45) at near range, deflect, or tear, or grazing, burn ; at middle range, perforate or penetrate, and uniformly comminute bone struck by them, and infect ; beyond range (1000 yards) they have lost momentum, have become flat, and imbed with laceration and often fracture.

Bombs, except lyddite, shells and large shot and projectiles of heavy field or naval ordinance cause serious

wounds, bad fractures, shock and death uniformly. Spent cannon-shot cause extensive injuries.

**Modern warfare** has brought several new elements into the field in the way of small arms. The modern *rifle*, Mauser or Krag-Jorgensen, is rapid-fire by means of magazine or blocks of cartridges. Its tube is of small (23-25) caliber, the rifling as it approaches the muzzle rapidly increases so as to give the bullet 2,000 revolutions per second. This insures accuracy of direction and prevents swaying of the bullet. The *powder* is smokeless, a cellulose powder such as cordite, of slow ignition but of great expansion force. It causes the ball to start slowly but to have at the muzzle a tremendous velocity, so that its range is from one to two miles. The *bullet* is of small caliber, is long, has a conical nose that is nickled or mantled with a german-silver cap, and has a soft lead base that on firing is thrown out into the rifling of the barrel. The *shell* is of drawn brass with solid base, a constricted neck and a rim that is pinched in upon the soft lead base of the bullet. These shells are frequently mounted in blocks of five to fit the breech of the rifle.

The opposites of Springfield rifles, black powder, and explosive, express, mushroom, soft-nosed or Dumdum bullets find frequent reports of their destructive work in the Abyssinian and Spanish wars.

A modern weapon such as the Mauser rifle starts a bullet with an initial velocity of 1,500 miles per hour and has a muzzle energy of 90 foot-pounds. Such a bullet *within range*, at a quarter or a half mile, gives explosive effects upon the body due in part to its velocity and in part to its swaying. There are lacerated wounds, key-holing of tissues and comminuted fractures of bone, the splinters

being driven into the tissues, but causing little or no sepsis. At *middle range*, varying from a quarter of a mile to a mile and a quarter, the bullet ceases to sway, loses in part its velocity, and causes boring effects. This is the range of warfare. The injuries are aseptic, due in large part to the heat of the bullet ; there are openings of entrance and exit slightly smaller than the bullet ; the fascia, muscle, blood vessels and nerves are largely split or pushed aside ; spongy bone is clean-drilled and compact bone is drilled, or drilled and fissured, or comminuted. *Beyond range*, up to two miles, swaying of the bullet, key-holing and explosion effects are again gotten. These bullets have usually completely penetrated the tissues, the wounds are clean-cut and the soft parts but little effected. If imbedded, the bullets are hard to extract. They are not deformed.

Contrasted with this, the old bullet of the Springfield rifle, at a half mile, deflected or ricochetted, or lodged in the tissues mushroomed or split, or tore out at its exit, or as a spent ball simply contused the surface. The wounds were uniformly septic, and the ball imbedded.

As a result of the wounds being aseptic and not causing hemorrhage, there is uniformly repair in 12 to 20 days. Fractures of bone are treated as simple fractures, wounds as simple wounds, by the aid of sublimate compresses. Whatever infection takes place is usually a secondary one. Injuries to joints are similarly aseptic and are to be treated as such. Modern hospital facilities and early primary dressings have reduced mortality over fifty percent and have largely diminished chronic invalidism. The X-rays save time in finding imbedded bullets in all parts of the body and protect the tissues from sepsis, that usually follows probing. Drainage is seldom used. The wounds may be irrigated, partially or wholly closed, and sublimate dressings applied. Splints are used as required.

In Manila hospitals, of 22,000 sick, seven percent had gunshot wounds. Of these, there were explosive injuries in five percent, usually situated in the long bones and the skull. There was a total mortality of 4.2 percent in these wounds, out of 20 percent infection. There, there was an excess of infected cases due to the kind of warfare, the prevalence of infection, and the general poor health of the soldiery.

## ANATOMY OF JOINTS. INFLAMMATION OF JOINTS. ANKYLOSIS.

The **joint**, or articulation, is the connection between two or more bones, usually for the purpose of allowing movement between them. Embryologically the joint is due to softening of the formative tissue lying between cartilage layers. It develops later than ligaments, and its endothelial membrane covers the cartilages and lines the capsule in bursal form. The joint consists of the articular bone ends, covered by the articular cartilages; a fibrous capsule, lined by an endothelial or synovial membrane, that contains the secretory fluid of the joint, the synovia; and certain bands or accessory ligaments. The joint is overlaid by muscle, tendon and fascial bands and has a rich blood and lymph and nerve supply.

The *articular cartilages* consist of hyaline cartilage that is semi-transparent, and lamellated, netted or reticulated. It is nourished by imbibition, having no blood vessels. This hyaline cartilage covers the articular bone ends. Its surface is smooth to obviate friction and its elasticity is such as to negate the slight traumata of locomotion. This cartilage is thickest where there is the most pressure or con-

cussion. Certain joints such as vertebrae and the symphysis have discs of white fibrous cartilage; certain others have white fibrous cartilage in the form of interarticular cartilage as the knee, or marginally as in the shoulder.

The *ligaments* are strong, pliable sheets and bands of fibrous connective tissue continuous with the periosteum. In the form of a more or less complete sac they constitute the *capsule* of the joint. This is strengthened and reinforced by accessory bands usually continuous with septal or intermuscular fascia, with tendon or retrograde muscle. A very few ligaments consist in whole or part of yellow elastic tissue.

Within the capsule is the *synovial membrane*, sometimes separated from it by subsynovial connective tissue. This membrane consists of flat endothelial cells, has presumably stomata for lymph vessel openings, is carried over capsule ligament and interarticular cartilage but usually ends at the margins of the articular cartilage. In certain joints it exists also as villi, folds and fringes, or contains fat pads that extend into or fill the joint cavity. This membrane is very vascular, being well supplied with both blood and lymph vessels. It secretes the *synovia*, or joint fluid, that is thick and glairy and lubricates the various joint surfaces. The synovial membrane extends well about the articular surfaces and connects often with adjacent bursae.

The *blood vessels* are small ramifications of the liberal plexus surrounding the joint and they and the *lymph vessels* supply mainly the folds and villi of the synovial membrane.

The *enervation* consists of branches that supply not only the joint, but the overlying muscle, skin and fascia as well.

**Inflammation** of a joint is caused by traumatism, rheumatism and gout, by bacteria, or by trophoneurotic changes. It may be mild or severe; acute, subacute or chronic; it

may end in resolution, or there are productive changes that deform or disable, or there is partial or total destruction of the joint structures. These inflammatory causes originate in the joint itself, or in the neighboring tissues such as bone, tendon sheath, or periarticular connective tissue ; or are brought in through the circulation. There is involvement of the synovial membrane only, a synovitis ; or the other joint structures are invaded, constituting an arthritis. In inflammation of a joint there are changes in circulation, in the cells and tissues composing the joint, and in function both of the synovial membrane and the joint as a whole.

In *acute* inflammation there is redness and swelling of the synovial membrane with or without newly formed granulation tissue ; or in addition serum is thrown out into the membrane, subsynovial connective tissue spaces, ligament interspaces and into the joint cavity ; or there is hemorrhage into the joint or ecchymosis in the membrane and its underlying connective tissue. There is proliferation of the endothelial cells that, cast off, makes the synovia milky. Or fibrin is thrown out as flakes or sheets into the joint cavity, or upon the cartilages, or on and into the membrane. At times there is new cell growth but this is usually chronic, and of tubercular origin. The cartilages suffer no change ; or they soften and absorb through pressure of serum or of the granulations ; or they flake off and erode ; or they atrophy and become thin and dry ; or they hypertrophy at the margins. The ligaments remain unaltered, or they degenerate and split under pressure, or they suffer amyloid changes. The functions of the joint are impaired by supra-abundance of fluid causing distention, or the fluid is scanty and the joint surfaces rub.

Or the inflammation is *chronic* in its course and there is cell infiltration causing fibrous connective tissue changes, usually with obliteration of the normal tissues, and func-

tional disturbances, and the production of joint bodies, contractures and ankylosis.

Joint inflammation is single or multiple. The acute inflammations are acute serous synovitis and acute purulent synovitis or arthritis ; and gonorrheal, rheumatic, syphilitic, tabetic and gouty affections of the joint. The chronic inflammations are chronic serous synovitis and chronic purulent synovitis or arthritis, chronic articular rheumatism, tubercular arthritis and arthritis deformans.

**Ankylosis** of joints, constituting partial or total loss of motion of the part, is caused by fibrous cartilaginous or bony adhesions within or without the original joint cavity. There is thickening of the synovial membrane, the formation of bands and scar tissue, causing dense fibrous connective tissue adhesions, and there is erosion of cartilage and of bone following osteochrondritis ; that results in cementing of cartilage growths on the bone ends and the formation of exostoses and osteophytic growths between contiguous bone surfaces. The bony and cartilaginous surfaces may be entirely changed by trauma or disease so as no longer to fit with one another. They thus form a mechanical obstruction to movement. This condition is farther abetted by fibrous adhesions that soon form in the joint. Or there are the simple fibrous adhesions that form in a joint in small amount due to non-use during splinting of fractures.

## ACUTE SEROUS SYNOVITIS. ACUTE PURULENT SYNOVITIS, OR ARTHRITIS.

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**Acute Serous Synovitis,** hydrops, is an acute exudative inflammation of the synovial membrane, usually caused by trauma, and characterized by hyperemia, a serofibrinous exudate and a tendency to speedy resolution.

**Lesion.** The joint is overfilled with a cloudy serum containing flakes of fibrin. There is hyperemia of the synovial membrane ; it is red and swollen, and has several foci of white blood cells, and petechial hemorrhage.

**Symptoms.** The joint is much swollen. There is considerable local heat, some redness, and there is considerable pain and tenderness. The joint is maintained in a semiflexed and relaxed position. There is often marked pain, or pain on either active or passive motion. On palpation there is marked fluctuation. The patient suffers for a few days with or without a little temperature, when the exudate begins to be absorbed and the pain disappears. In a few more days the fluid has disappeared entirely.

Or the exudate becomes purulent. Or the acute serous inflammation becomes chronic.

**Prognosis** is uniformly good if cared for.

**Treatment.** Rest, by splinting if necessary. Elevation. Ice. After the pain has in part disappeared, pad the joint in cotton and apply a firm bandage. In cases of excessive serous exudate, puffing out all parts of the synovial membrane to its limit, and causing extreme pain, prepare the skin surface carefully and aspirate the joint aseptically. This prevents as a rule destruction of the membrane through pressure and congestion. The parts soon return to

normal. Or rarely, a second aspiration is necessary. Do not limit the motion in the joint too long for fear of fibrous ankylosis. Watch the patient and maintain his general strength and elimination.

**Acute Purulent Synovitis, or Arthritis,** is an acute exudative inflammation of the synovial membrane, or of the structures of a joint generally, usually caused by infection, and characterized by marked hyperemia, a purulent exudate, and termination by resolution, ankylosis or general erosion of the joint structures.

**Lesion.** This inflammation may follow an acute serous synovitis ; or it may begin suddenly as an acute purulent synovitis with the formation of thick pus, with or without floccules of fibrin ; or it may constitute an arthritis secondary to the general infectious diseases, the exanthems, pneumonia, mumps and typhoid.

The *mild* cases may begin with a sero-fibrinous exudate that soon becomes purulent. The synovial membrane is hyperemic and swollen and proliferates over the cartilages. The cartilages are swollen and dull, and may undergo a beginning fibrillization. The joint is filled with pus. The ligaments are swollen and infiltrated, and covered with patches of fibrin and foci of pus. The inflammation undergoes resolution, with or without fibrous adhesions.

Or the cases are *severe* from the onset. All parts of the joint structure are attacked. The synovial membrane becomes covered with granulations. It necroses at certain points and the pus escapes into the adjacent structures. The cartilages become very swollen and hazy, and necrose, and erosions form, or these erosions develop into caries of

the bone ends. The ligamentous structures may infiltrate, undergo degenerative changes and allow the pus to escape to form periarticular abscess, or suppurative osteomyelitis of the contiguous bones. Or all the joint structures are obliterated and invaded by granulation tissue. Or the joint is pyemic or gangrenous.

**Symptoms** are those of acute suppuration.

In the *mild* cases, there is a chill, high temperature, great swelling, pain and disturbance of function. The patient is worried, keeps the joint semiflexed and winces upon the slightest movement or pressure. The joint is intensely painful, reddened and hot. The whole extremity may be involved and edematous. There is fluctuation at the joint. The patient often has the general symptoms of a septic infection.

The *severe* cases are ushered in more rapidly and run a more marked course. The limb is early red, edematous and swollen throughout. Movement of the limb is not possible without causing the patient excruciating pain. There may even be pyemic symptoms, or coma and death from gangrene of the joint.

**Diagnosis** is determined from the history, by the character of the fluctuation and by aspiration of the joint.

**Prognosis** is good, with early treatment in the mild cases. In the severe cases, it depends entirely upon how early and how heroic the treatment is and upon the final result. Prognosis is always serious and often grave.

**Treatment.** Under an anesthetic clean the skin and aspirate the joint. If the pus is very thick and flocculent, follow the needle as a guide and make a wide incision of the joint. Upon the opposite side make a similar counter opening. Irrigate the joint thoroughly, thread the joint with gauze or lightly pack it. Apply an angled splint and re-dress frequently. When the exudate begins to be

serous and slight in amount remove the gauze drains and begin passive motion, and avoid contractures.

The pyemic and gangrenous joints need wider incision, more frequent dressings and perfect drainage. Or amputate.

In some suppurative joints, especially those of a subacute type, there may be luxation due to general erosions of the joint. These need mechanical braces or orthopedic appliances in order to form a working joint.

In certain cases joints undergo an inflammation where there is **excessive coagulation of fibrin.** These joints are very painful, have slight swelling or redness, and no fluctuation. They are dry, have no mobility, often crepitate, and will ankylose unless interfered with. Open and carefully scrape out, irrigate and pack the joint. Begin passive motion early.

## GONORRHEAL ARTHRITIS. GOUT. ACUTE RHEUMATISM.

**Gonorrheal arthritis** is an acute serous, rarely purulent, synovitis, due to septic infection from a subacute or chronic gonorrhea involving the deep urethra. It is presumably metastatic. The gonococcus is rarely found in the joint. The inflammation is usually monarticular but may be polyarticular. The joints affected, in order of frequency, are the knee, ankle, shoulder, wrist, hip, elbow.

The exudate is largely serous and may be present in very considerable quantity.

The **prognosis** is usually favorable, even in the purulent cases.

**Treatment** is directed first toward curing the gonorrhea. Apply antiphlogistics to the joint, or aspirate, or rarely incise the joint and irrigate.

**Gout** is a constitutional disease, due to the presence of uric acid and alkaline urates in the circulation, and is characterized by the formation of tophi of sodium urate in the articular cartilage, capsule and ligaments of the metatarsophalangeal joint of the great toe. Tophi are also present in the helix of the ear.

There is serous effusion into the great toe joint. The joint becomes red, very swollen and shiny, painful and very tender on pressure. The lesion is acute, comes on in attacks generally beginning at night, and after a few days or weeks subsides. The lesion is paroxysmal and recurrent.

Gout regularly occurs after forty years in patients that are of full habit, hearty eaters and regular drinkers. It also occurs as well in the underfed.

**Prognosis** is very favorable except as to return of the lesion.

**Treatment** is alkaline diuresis and flushing of the bodily fluids. Antiphlogistics to the joint.

**Acute Rheumatism** is an acute self-limiting disease, or expression of the uric acid diathesis, characterized by acute constitutional symptoms and serous exudate into the large joints, and a tendency to relapse. It is at times monarticular, more often multiple, and has a peculiar habit of jumping quickly from joint to joint.

The joints are very red, swollen, tense and often shiny. There is hyperesthesia of the overlying skin and near-by tissues. It is a disease of young people and often runs high

temperatures, especially when the joint lesions are multiple and severe. The idiosyncrasy of rapidly clearing up in one joint, to appear simultaneously at one or more other joints often widely separated, is an especial characteristic.

**Prognosis** is oftenest good, except for cardiac involvement.

**Treatment** is alkaline flushing, supporting, stimulating and analgesic. Keep the patient in bed till cured. Heat is most grateful to the joints.

## CHRONIC INFLAMMATIONS OF JOINTS—DRY, SEROUS, SUPPURATIVE. TUBERCULAR ARTHRITIS. SYPHILITIC ARTHRITIS. CHRONIC RHEUMATISM. ARTHRITIS DEFORMANS.

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**Simple chronic synovitis** is a mildly productive inflammation of the synovial membrane, usually caused by trauma, loose joint bodies, or a preceding acute serous synovitis, and is characterized by the formation of a dry joint or hydrops, often without inflammatory manifestations. It is most common in the knee joint.

**Lesion.** The joint fluid is either in small amount or markedly distends the capsule. The fluid is usually thin and watery, or it may be thick and gelatinous, and is often clouded with thrown off endothelial cells. After a considerable time the synovial membrane becomes thickened, the villi proliferate, the articular cartilages become fibrillated and thickened, and the synovial membrane grows over the cartilage surfaces, or occasionally at weak points of the capsule forms occasional protrusions. The ligaments and capsule, through pressure of the contained fluid, may become

stretched and flail like and allow luxations. Or the capsule may burst.

**Symptoms.** The joints may be *dry*, due to a small amount of fluid, general thickening and proliferation of the various structures, and give a crepitus that is felt and heard on motion of the joint. This condition is apt to produce joint bodies from the multiplied villi.

Or the joint is filled with *serous effusion*. Practically the same conditions are present as in the dry cases and in addition the joint is enormously distended by the exudate. Joint bodies are often formed in these cases.

There is a tendency in chronic synovitis for the patient to nurse the joint and not use it. Aside from the functional disturbance there are few symptoms.

**Prognosis** under treatment is good, save for the joint bodies, the presence of which tends to cause the lesion and symptoms to recur.

**Diagnosis.** Chronic synovitis is to be carefully differentiated from other joint lesions on account of the treatment. The long history and the local symptoms will confirm the diagnosis.

**Treatment.** Aspirate the joint as required. Bandage the joint or apply a well-fitted elastic bandage in order to maintain pressure. Massage two or three times a day. Use hot needle baths. Exercise the joint. Occasionally purse up the capsule, if too baggy, by a few sutures.

**Chronic purulent synovitis, or arthritis,** is due to a preceding acute inflammation, to metastasis, or to extension from neighboring structures.

The **lesion** varies little from the acute cases, except that there are more pronounced productive changes. The synovial membrane is infiltrated, hyperemic and covered

with boggy flakes of mixed fibrin, pus and debris ; the cartilage is fibrillated and thickened, or is eroded to or into bone, or is entirely destroyed. The inflammation invades the capsule, ligaments and bone, and sets up septic infection in the outside tissues and in the bone. The joint is entirely destroyed, or in parts only ; but in all cases ankylosis results when the spread of the lesion and the infection does not kill the patient nor demand amputation of the part.

**Symptoms** are those of acute suppuration, extended in lesion and in duration.

**Diagnose** from the acute lesion and from tubercular joint by the history and course.

**Prognosis** is fair only for life, when taken early. The joint is uniformly destroyed as a joint, or requires excision.

**Treatment** is incision, irrigation and drainage, with or without curetting ; or partial or total arthrotomy.

**Tubercular arthritis** usually develops subsequent to a tubercular osteomyelitis, generally of an adjacent bone, abetted by a more or less recent traumatism of the joint. Or it develops primarily in the joint, by metastasis from some remote part of the body.

**Lesion.** The tubercles develop as greyish white or yellowish red nodules scattered upon a hyperemic synovial membrane. There is a sero-fibrinous exudate into the cavity of the joint, that soon changes into pus as the tubercles change into boggy red granulations. These grow out to fill the whole joint cavity, and to invade and degenerate all the joint structures. Necrotic changes in the granulations form rice bodies. The bone necroses as a whole, or locally, forming sequestra. The articular cartilage also degenerates, in the form of multiple erosions, or patches, or totally.

The granulation tissue degenerates into caseous material, suppurates and is thrown off through fistulae. The bones, in their joint surfaces especially, undergo caries and necrosis and there is produced luxations, wandering of joint surfaces, kyphoses; or joints become obliterated or ankylosed.

The various lesions have a tendency to undergo evident healing at any stage of the inflammation. But they have equal tendency to erupt and go on developing again.

**Course.** The course is an exceedingly long one, lasting for years, with latent periods and exascerbations. As in tubercular osteomyelitis, tubercular joint is particularly a child's disease, beginning as early as one to two years, and rarely happening after fifteen years. The joints usually affected are in order of frequency, the hip, knee, ankle and wrist.

**Symptoms** are gradual swelling without redness, with some considerable pain not always referred to the inflamed joint, and not at first sufficient to prevent the child from awkwardly using the joint. Later there is more pain on use, more swelling, and there is fixation and contractures.

Later, these symptoms become intensified and there is additional local pain, marking a fluctuation point. Joint changes now become more active, and give their added symptoms.

**Diagnosis.** Occasionally the onset of these symptoms is comparatively rapid, and in association with general symptoms of temperature, emaciation and diarrhea, these cases are diagnosed rheumatism or typhoid, until subsequent deformity or accident corrects the diagnosis.

Or the course is chronic from the start with an occasional exascerbation, and diagnosis is made only through the gradual loss of function and the progressive distortion.

**Prognosis.** The patient's joints may cease from

active inflammation after a time, to break out again after many years, or to remain latent for life. These patients seldom live beyond 40 to 45 years and die from pneumonia or some other acute visceral lesion.

**Treatment.** Early, absolute and uninterrupted rest for the joint, for two to three years, usually with moderate pressure. Later, in the event of destructive lesions, orthopedic appliances to obviate or to correct deformities. When caries or necrosis appears, with suppuration, operate and clean out. The operation wounds heal slowly, but best with iodoform dressings. Passive congestion, carried only into the warm stage, is often of benefit in the early lesion. Very late, after erosion but before bone infection, resections may be made, with or without production of a false joint. Or high amputations are done to save life.

**Syphilitic arthritis** is a joint disease usually of late syphilis. It ranges in extent from simple serous synovitis, polyarticular, and causing few symptoms; to those of gummatous (carious) destruction of bone, cicatrization and fibrillization of the cartilages, thickenings and villification of the membrane, and amyloid degeneration of the ligamentous structures, with more or less of sero-fibrinous exudate into the joint.

**Treatment.** Local and general. Antiphlogistics. Mercurial inunctions with full doses of the iodides.

**Chronic rheumatism** has its lesions largely in the last two phalangeal joints of the fingers and toes. Tophi keep up chronic irritation, with exascerbations of inflammation. There is much fibrous tissue thickenings, and ankylosis, and exostoses and joint distortions. The joints in their

active periods are slightly reddened, painful and swollen, and painful on pressure.

Or occasionally a chronic joint follows an acute inflammation of a large joint, when practically these same changes take place.

**Treatment.** Patience. Baths. Alkaline and sulfurous waters. Travel. Splints, between exascerbations, to prevent deformities.

**Arthritis deformans** is a comparatively uncommon joint disease that in youth is multiarticular, is regularly progressive and very painful in the exascerbations, and causes bad deformities. It is also often monarticular.

**Lesion** consists in degenerative processes of bone and cartilage, in combination with marked hyperplasia of bone and cartilage and the soft parts, both within and without the joint. The joints are destroyed, or ankylosed and distorted.

**Symptoms** are those of great destruction and great distortion of the joint. There is very little or no fever and general disturbance. There is considerable, very little or no pain, depending upon the lesion and the stage of the inflammation. Recovery is rarely had.

**Diagnose** by its chronic character, acute stages with excessive pain, but without temperature or suppuration.

**Treatment.** None efficient known.

## JOINT BODIES. JOINT MICE. RICE BODIES.

**Joint bodies** are bits of bone, cartilage, fibrous connective tissue, or fibrin, of varying size and number, with or without pedicles, found in a joint. They are caused by

trauma, by multiple fracture involving a joint, by acute fibrinous synovitis, by chronic synovitis, and especially by tubercular arthritis. They have a special predilection for the knee joint, where they are to be differentiated from recently displaced semilunar cartilages. There are often two to five or six of pea size or walnut size ; or when small are many in number and constitute "rice bodies," that often fill up all the pockets of the joint.

**Lesion.** The bodies are largely derived from villous outgrowths, developing cartilage cells and then becoming more or less ossified ; from the detached osteophytic outgrowths of arthritis ; from detached cartilage due to trauma or slow necrotic changes ; or from detached tubercular fringes and bits of membrane. They are usually associated with tubercular and rheumatic diathesis and their associated lesions, more or less active. They frequently cause absorption or erosion of bony joint processes, if large and few in number ; and if small and in considerable numbers, they simply keep up the irritation of chronic arthritis.

**Symptoms** are those of fullness of the joint, or sense of the presence of some foreign body in the joint, together with symptoms of the chronic arthritis. Occasionally one of these larger bodies will be pinched at some point, in flexion of the joint, and there is sudden twinging or sickening pain ; flexion is stopped and the patient falls to the ground, perhaps fainting. On examination the body is not to be found and there is only a sense of soreness at or near the periphery of the joint ; or there is lodgement, and arrest of joint motion. The irritation of this traumatism causes pain and serous effusion for a short time. Then there is a varying interval of cessation, and recurrence. Frequent recurrence of the attacks causes hydrops of the joint, and together they warrant operative interference.

**Diagnosis** is not easy. The patient is seldom seen during the lodgement of the joint body. Occasionally only is the body found, to slip away easily under the finger. Dislocation of semilunar cartilage gives a history of previous severe sprain, presence of its free border forward or backward, or movability, together with more severe pain and locking of the joint.

**Prognosis** is perfectly good.

**Treatment** is operative. The body is fixed if possible, anesthetic given, aseptic incision made over the body and often one or more removed. More commonly and profitably, no attention is paid to location of these bodies, as they are usually multiple. The joint is opened freely, the bodies are fished or flushed out, often with difficulty, or snipped close to their pedicled bases. The joint is sutured, dressed and placed in a retention splint ; and passive motion is begun after two to three weeks, to prevent fibrous ankylosis. Otherwise the treatment is prophylactic, trending to operative interference and the securing of a useful joint.

## NEUROSES. NEUROPATHIES OR ARTHROPATHIES.

The common **neuroses of joints** comprise the hysterical joint and the so-called neuralgias of joints. Neuroses proper occur in the worn-out society woman, and in the neurasthenic, and in women without a purpose in life. They are rare in man. These joints follow sprains, bruises, nervous shock, "catching cold," and even so slight a cause as a too-tight garter. These neuroses are largely psychic, occasionally due to mild cerebral shock, or spinal, or both as in railroad spine. Lightning produces functional neuroses ; as also at

times, insolation. The joint neuroses are usually confined to the knee and hip. One or more joints may be affected and the patient takes to bed, The patients are often emotional, and the cause more or less so.

**Lesion** none. Parenthetically, these patient refuse operation and do not come to autopsy.

**Symptoms** are pain in the affected joint; the limb is very painful throughout, and is tender, swollen and fixed in a semiflexed position. There is pain, steady and grinding, referred to the back and sternum, and there is often occipital headache. On examination of the joint, there is nothing felt, or a cartilage may seem nodular. The position of the limb is characteristic; there is the fixation of restraint. The examination causes excruciating pain; or, rarely, pain is entirely absent and the joint is semi-relaxed, but with prominent muscle tendons stretched; or there is pain when the limb is in certain postures; or there is pain only when the joint is used. Or the joints are held rigidly. On use they are uniformly ataxic. There is always pain. Yet when the patient's attention is distracted it is less, yet present. At night the pain is not worse and yet it is present. In the bones and joints there is less pain than in the soft parts, and yet the trouble is referred to the joint. When in the knee, it is referred there; when in the hip, the pain is present in both hip and knee and in the intervening thigh. Over and around the joint, the skin is especially hyperesthetic; or it later becomes analgesic; or the affected joint, first hyperesthetic, transfers the hyperesthesia to the well joint and becomes itself analygesic, Or there is paralysis, paralgesia, hemiplegia or hemianesthesia; or by the use of cold plates, or simply by suggestion, any or all combinations and transfers are to be gotten. Or there is muscular spasm and persistent subsequent contractions, that may be permanent and cause the atrophy of disuse. Or

there may be vasomotor disturbance ; the skin is reddened, or blanched, or cyanotic ; there is swelling, that is in welts or wheals, or is diffuse and edematous ; or the skin is drawn and dry, causing alopecia. Or there is fibrillar tremor of the muscles of the part, or of the body generally. Or the patient is asthenic, and the joint is asthenic, relaxed and useless. There is polyurea, phosphaturea or functional glycosurea. There is regularly constipation and atony of the gut.

The patient is preeminently of emotional type, though this is often masked by the asthenia. There is general nervous weakness and insomnia. The tendon reflexes are increased, often markedly so, or there is simply increased excitability of muscle and nerve. There is functional tachycardia, or palpitation, or sense of cerebral pulsation. The patient is hypochondriacal or melancholic to the point of considering her case perfectly hopeless. She is often depressed by fear and a sense of unrest, or has terrors and hallucinations. She cries over her condition. She has loss of memory, and deplores it. There is marked headache, vertigo when quiet, or on attempting to rise ; or the patient lapses into unconsciousness but with unrelaxed muscles and twitching lids. Or there is pseudo-epileptic seizures and muscular spasm. Or there is loss of morale, perversion of the special senses, or the patient develops into a pervert.

**Prognosis** is good as to life of the patient. Yet the hysterical joint or contracture may become fixed, and permanent changes follow if not controlled.

**Diagnosis.** The lesion is hysterical to a degree. The patient is sick and is in pain. And yet there is no inflammation, no fever ; and both pain and swelling and the contracture disappear under an anesthetic. Frequently the patient, in the acme of the disease, rises, dresses and goes

about her business, well. Or unwatched, she does the impossible, watched.

**Treatment.** Following trauma, such as railroad spine, a good verdict cures the patient. As psychic shocks have caused the disease, so shocking cures them. A fire in the vicinity, cold plunges, pressure over the ovaries, harsh treatment often,—all these avail to clear the horizon. Otherwise make use of supporting diet, exercise and galvanism. Give the patient hypodermics of ice water and placebos. Alcohol and drugs are worse than useless. Treat the patient cheerfully yet firmly.

**Joint neuralgia** is a joint neurosis but the symptoms are almost entirely confined to the joint. The disease occurs about equally in men and women. There is hyperesthesia of the skin over the joint, but there is neither redness nor swelling, as a rule.

**Occurence.** In women, it pretty regularly follows disease or irritation of the abdominal viscera or the sexual organs. It pretty regularly occurs in rounders that are alcoholic, and is concomitant with the osteosclerosis of syphilis.

**Lesion** is nothing especially. The patients are simply neurotic, or neurasthenic. Or there are small adhesions. Or there is pinching of a terminal nerve by reparative inflammation in or about a joint. Or a neurotic patient "catches cold" in a joint.

**Symptoms** are referred to a knee or hip. There is steady or paroxysmal pain in the joint, radiating up the thigh, or to the gluteal and lumbar region. The pain is often indefinite, being referred equally or alternately to muscle or joint. It is not worse at night, and often allows the patient to rest. The joint is generally sensitive and

may undergo hysterical contracture; in which case the skin may be swollen, and if long contracted there is slight atrophy of muscle. Use of the joint is painful and causes excessive limping.

**Diagnosis** is that of a joint neurosis; but may be differentiable through lack of many general symptoms and the fact that the patient persists in being up and about.

**Prognosis** is indefinite. The patients recover or they do not. Or they disappear, to appear again in the hands of specialists, or quacks, or they go the rounds of the various health resorts here and abroad. Occasionally they return to us for aid, or to tell us that the last treatment gave them complete and lasting relief. Or they become discouraged and give up all treatment. Or after reading up all the text books and special monographs they submit to an unnecessary operation and are cured. Or they suicide.

The **treatment** is based upon the process of exclusion. If there are joint lesions under an anesthetic, operate. Otherwise learn your patient well and treat him accordingly, giving him the benefit of the doubt. Use tact, energy and metaphysics. Gain his confidence and use few drugs, and few or no heroic external applications.

**Cramps of missing limbs,** such as those of amputation, are to be classed in this category. Occasionally a nerve trunk is found bulbous, irritable, and caught in the scar of repair. Exceptionally a patient, such as an Australian, consults all the clinics of England, the continent, and of this country, and has no relief. The cause is often indeterminable and the treatment of no avail. These cases are undoubtedly neurotic.

The principal **neuropathies** or **arthropathies** are those of locomotor ataxia or tabes, and the rarer syringomyelia. The joint lesions occur rather late in these diseases, after there has developed pretty general analgesia and trophic disturbances. *Tabes* is a chronic disease of adult life, occurring from 35 to 50 years, and runs a course extending over a decade or more. *Syringomyelia* is a chronic disease of adolescent or middle life, occuring from 12 to 35 years, and runs a course lasting only two to five years. Both diseases are regularly progressive and, together with the joint lesion, incurable.

**Occurrence.** The arthropathy of *tabes*, Charcot's joint, is of short duration and occurs in order of frequency in the knee, hip, shoulder, elbow, ribs, tarsus, ankle and hand. The lesion is active for weeks or months. The arthropathy of *syringomyelia* is chronic and occurs only in the upper extremity, usually the shoulder and elbow. The lesion may extend over years, with intermissions of quiet.

**Lesion.** In *tabes*, the joint appears swollen and edematous. There is neither pain, redness nor temperature. The bones are soft and brittle, the cartilages dry and friable, and the serous exudate excessive. The joint structures are at once analgesic and anesthetic and the patient uses the joints despite and in spite of their inflamed condition. The result is that the joint parts become rapidly destroyed, with or without new bone formation. There are luxations and subluxuations, distortion of joints and so-called spontaneous fractures. There is local atrophy and hypertrophy. Or there is atrophy of one or more joints. The joints pretty regularly become ankylosed in their deformed condition.

There is associated, often, *perforating ulcer* of the sole, involving the big toe joint. Or there is *spontaneous gangrene* of the skin and nails.

In *syringomyelia*, following injury, there is intra-articular and periarticular osteophytosis. There is ossification of the soft parts extending to the joint. The muscles degenerate ; the capsule dilates, thickens and relaxes, allowing distortions if not subluxations of the joints. This frequently is termed secondary spontaneous dislocation. Or the bone becomes weak, and fractures ; or it becomes sclerotic. All this time the joint is analgesic. There is excessive fluid in the joint. There is occasionally ankylosis.

Occasionally *blebs* form on the skin of the arm, break, infect, and form indolent ulcers.

**Diagnosis** is of recent years getting to be well understood.

**Prognosis** is that of the two diseases, unfavorable. The patients suffer no pain from the inflamed joints but a very considerable inconvenience from the flail like, distorted, ankylosed or dislocated joints and from the fractures.

**Treatment** is primarily prophylactic to prevent the injuries, fractures, or excessive use of the joints. Otherwise retention and correction splints are applied to procure orthopedic ankylosis. Or the joints are resected and nailed. Arthrotomy is done at times to clear up the joint lesion, if small. If the joints become suppurative, as they rarely do, the pus is emptied and drained as in simple purulent arthritis.

## CONTRACTURES. CONGENITAL DEFORMITIES.

**Contractures** consist of permanent approximations of the component parts of a joint. These changes are purely

extra-articular, being in skin, fascia, tendon, muscle, and in scars, fibrous bands and adhesions. They are both arthrogenic and non-arthrogenic in origin. They follow fractures, especially those near joints, and are associated with that form of muscular atrophy that is due to the splinting, or disuse. They are a part of certain joint lesions such as chronic rheumatism, tubercular arthritis, arthritis deformans, the arthroses, and hysterical joint. They pretty generally follow paralyses, such as diphtheritic paralysis and anterior poliomyelitis of children, the paralysis of apoplexy, the various muscle atrophies and cicatricies and the extensive cicatricies of large mangling wounds or of extensive and deep burns. They follow the cicatrization of tissue removes in plastic surgery. The contracture is usually proportionate to the amount of tissue and the length of muscle or tendon or fascia involved. At times the contracture is due solely to cicatrization of the skin and fascia ; at others, only the substructures are involved ; at others, only a single tendon is involved ; and at still others, contracture is brought about through irritation and inflammation of a muscle or group of muscles and interstitial thickening or ossification.

Or, contractures are present with associated bone and fascial malformation, due to structural changes, in the so-called **congenital deformities** such as club-hand, webbed fingers, knock-knees, bow-legs, club-foot, flat-foot, hammer-toe, bunion, and pes varus equinus and calcaneus. Many of these conditions are congenital, but a very great proportion of the cases are due to tubercular lesions and especially to rachitis. Many also are capable of correction in youth by the use of simple orthopedic apparatus ; and many may have been prevented by suitable correction exercises and prohibition of overlong and excessive exercise and posture.

**Symptoms** are mainly those of limitation of use and function. The congenital deformities of the foot markedly interfere with both locomotion and livelihood.

**Diagnosis** is usually easy except in atypical cases, especially of cerebro-spinal origin.

**Prognosis** is uniformly good. Most contractures are either benefitted or entirely eradicated as far as function is concerned. The deformities are made useful, though ugly in cosmetic effect.

**Treatment** varies with the particular case. The paralytic cases are maintained in muscular tone, through galvanism and massage, till tropic centers again assume control. The contractures of disuse and cicatrix are corrected by gradual orthopedic extension. Or the contracture or deformity is operated upon aseptically, and tenotomy, myotomy, osteotomy, osteectomy, arthrotomy, or general plastic surgery is done. The parts are then placed in retention splints or cast until repair takes place; when the various forms of massage are used. Or in a few cases of contracture, the carrying of weights or the use of permanent traction or temporary pulls is made use of. These contractures and deformities are capable of very great alleviation if the patients will but help in bringing about repair and reconstruction by the after treatment.

## TRAUMATIC INJURIES OF JOINTS. CONTUSIONS. SPRAINS. WOUNDS. DISLOCATION.

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**Traumatic injuries of joints** vary from the mildest bruise or contusion to the entire mangling and disruption of the various structures. These injuries are either subcutan-

eous or open, and are due to direct or indirect violence. Or as in the case of sprains and habitual dislocations, they are often due to causes scarcely to be called traumatic. Joint injuries comprise contusion ; sprain, with or without associated tendon strain ; traumatic, spontaneous, and congenital dislocation, or luxation ; and wounds of joint structures, usually infected.

**Contusion,** or bruise, of a joint consists of direct injury to the unprotected parts of the joint, usually the lateral ligamentous structures and synovial membrane, due to blows or kicks ; or there is contusion of the cartilages by indirect violence as by falls, or injuries by contrecoup. There may be contusion of the cartilage, with or without separation from the bone ; or scaling of the bone, or fracture. There is more or less damage to the blood-vessel plexuses and the nerves, with hemorrhage into the superficial tissues or into the joint. Or there is thrombosis of the vessels and serous effusion into the tissues and joint, and tension. The hemorrhage is considerable in bleeders and scurvy, occasionally so in syphilis ; or it is considerable after only slight trauma.

**Symptoms.** There is pain and throbbing in the part ; sharp or knife pains on pressure. The joint is kept semiflexed and relaxed, in so far as possible.

Or there is scarcely any functional disturbance. The part is puffed and swollen only.

Or there is infiltration of the skin by hemorrhage and exudate, far beyond the limits of the contusion, and corresponding increase in the pain of the injury. There is slight or considerable pain on motion with distinct functional disturbance if there is much hemorrhage. The joint is kept quiet. Later there are color changes.

Or there is concussion of the cartilages with or without joint effusion. There is little pain except when the patient tries to walk or use the joint.

Or with extensive hemorrhage into the joint, there may be little or no external swelling. The joint seems normal in appearance but it is exceedingly painful and the patient begs not to have it moved or touched ; or the capsule is tense and bags at some thin point. In these cases there is usually quick coagulation and absorption of the serous and cellular elements and after a day or two there is only a contained viscid sanious fluid that is soon taken up by the lymph.

Or there is serous synovitis and much exudate, rarely purulent, complicating the repair of the contusion. Or a tubercular arthritis, latent before, is made active.

Rarely there is death of tissue due to the swelling following trauma. There is pain, or not, with more or less added symptoms. Repair is slow and there may result productive tissue changes and functional inconvenience for a time.

**Treatment.** Bandage the part snugly and give an opiate. Keep the patient in bed and the part elevated. Apply cold if agreeable. After one to three days, the hemorrhage and exudate and their pain have disappeared ; then employ massage and passive motion. Basket-strap the parts with Z. O. adhesive plaster and allow the patient to go about his or her business.

If there is a purulent synovitis, with its heat, pain, redness and swelling, aspirate or open the joint. If there is marked complicating hydrops,. aspirate. In fracture complication, bandage or strap and treat as a fracture.

**Sprain** is a painful temporary distortion of a joint, due to trauma, that causes partial rupture of the ligamentous structures and overlying soft parts without permanent displacement of the other structures. It usually occurs in wrist and ankle and is subcutaneous. Or the movements are carried beyond the physiological limits of the part and for a time there is dislocation, but immediate return to normal when the causal force ceases. Or there is associated marked hemorrhage ; dislocation of tendon, and rarely of muscle, due to rupture of the binding ligaments or fibrous fascial bands. Or there is fracture of malleolar tips of the proximal bones, or scaling.

**Symptoms.** There is immediate severe pain in the joint so that the patient is unable to walk or use the joint, or falls or fails, or faints. There is swelling, or there is such immediate puffing or edema as to entirely mask the joint contours or prevent for a time any certainty of examination of the part. There may be actual hemorrhage into the tissues, or hematoma ; or into the joint, hemarthrosis. This much increases the already painful and tender part. The pain is often agonizing and causes the patient to writhe, or yell or weep, or to be abusive or hysterical. With hemorrhage there is always nerve dyscrasia. If examined early, the point of ligament rupture or ruptures is determined by the pain that is caused by pressure of the examining finger. The points of hemorrhage are even more painful. If examined late, the parts are so generally swollen and painful as to defy any protracted examination, or any determination other than the exclusion of possible dislocation and fracture. The amount of pain and its character predetermines the amount of hemorrhage, its diffusion and the length of time the swelling will continue before absorption takes place. With subsidence of swelling, there is decrease in pain and return of function. The

ligament or ligaments remain slightly painful on pressure for a considerable time longer. The discoloration clears up with absorption, and along with subsidence of swelling and decrease of pain.

**Diagnosis** should exclude fracture and dislocation, and determine the length of time needed for repair.

**Prognosis** is good if the joint is elevated, or is not used, or is not massaged. The issue of the injury depends upon ligament repair, absolutely. The care for the hemorrhage and its incident pain is entirely secondary, except as it affects the comfort and general well being of the patient, or influences or delays ligament repair.

**Treatment.** Determine joint parts to be in normal relation and position ; and bandage. For the sake of comfort, allow slight flexion of the wrist and extension of the ankle and do not bandage too snugly. Be careful that the bandage is smooth and of even tension. Then elevate the part, keeping the patient and the part quiet, especially in the abrupt and the severe cases. Give opium to quiet the pain and the restlessness. If necessary put the patient in bed. Rest is an absolute desideratum and makes for repair ; or in the want of it, the worst of results. Later, when swelling and pain have subsided, if the injury is a slight one, basket-strap the part from its extreme point centrally, carrying a light gauze bandage over the extremity to equalize circulatory pressure ; and allow use of the part. Or if severe, apply a light cast ; and when all pain is gone, allow use of the joint with the cast on. A week after all pain has gone, remove the cast ; employ active and passive motion, friction and hot baths ; and bandage with light canton flannel daily. Repair is, in this way, permanent and there are no complicating "weak ankles or wrists," loose ligaments and capsule, or serous synovitis, or deformity or ankylosis, or chronic (productive) synovitis. Mas-

sage, late, is very useful; early, it is both irrational and mischievous. Repair takes four days to three or four weeks. Or, as a result of early massage, of home care treatments and use of the joint, there are loose or ununited ligaments or serous synovitis causing subluxations and loose insecure joints subject to re-spraining and the sprain habit. The care of these conditions is possible only through the use of elastic or leather wristlets or anklets for life. Or flaccid membranes and ligaments may be sutured in folds, and shortened.

The so-called **back sprains** constitute varying combinations of lumbago; muscle trauma; muscle bundle rupture or muscle rupture; rupture of tendon or ligament; or rupture of nerves or neuralgia, or the neuralgia accompanying caries of the spine; or spinal shock.

The pain is usually unilateral; is pretty constant and consistent; and is referred up to the ribs and cartilages, or is referred to the pubes, or radiates down the thigh and leg to the peripheral distribution of the involved nerve trunk. The pain clears up in part with heat, rest, detracted attention, and usually always at night.

Treatment, following a differential determination of the cause, is directed to that cause. Otherwise, locally, satisfy the condition by simple plasters or strapping, and keep the patient quiet and eliminating his waste products.

**Wounds of joints** are punctured, incised, lacerated, mangling; or complicated with fracture, dislocation, or gunshot wounds. Practically, however, they are of two sorts, the penetrating wounds and those that do not penetrate. Again, they are simple wounds, or they are infected

or they become so. All wounds of joints, simple as they may be, and septic penetrating wounds especially, require the most energetic treatment often to prevent septicemia, or gangrene, and death. These latter wounds run a particularly rapid and virulent course.

*Simple wounds about a joint* are to be cleaned thoroughly, scraped and flushed out if necessary, sutured and a sublimate dressing applied. If sufficiently large, or if there is sufficient laceration or contusion of the flaps to warrant it, a retaining splint should be applied to prevent motion and hasten repair. Lacerated wounds cause cicatrices.

*Badly lacerated wounds* probably *infected* and all old *septic wounds* in the neighborhood of a joint are to be treated heroically to prevent spread of infection, and infection of the joint. Suspicious and devitalized tissue is to be cleared away by scissors and curet, the wound packed with sublimate gauze and a large wet dressing applied. After a day or two of this treatment, substantial granulations appear in the wound, the packing is loosely applied, or omitted and only the dressing is applied, to be renewed from time to time till repair is complete. A splint helps, and may be continued until a short time after full repair of the wound.

*Simple penetrating wounds*, even if done by clean instruments, demand the best of care and are always to be watched with the utmost suspicion. There may or may not be escape of synovial fluid. The wound bleeds and there is blood in the synovial cavity. There is often very considerable pain. On closure of the wound, the blood is absorbed. There is often considerable serous exudate in the capsule for some time. Under aseptic treatment and a sublimate pad dressing, these wounds frequently repair primarily with no inflammation nor loss of function. Or there

is, at most, a little acute or subacute serous synovitis, the more especially if the part has not been restricted by a a splint.

Or if the wound is large and there is escape of abundant synovia, it is well to irrigate the wound and the joint capsule thoroughly with hot saline, suture the membrane at frequent intervals, close the superficial parts by suture and usually without drainage, apply a large sterile dressing and splint. If this treatment is aseptic, even in cases of slight infection, there are good chances of primary repair without adhesions or loss of function.

*Infected penetrated wounds*, even though small as those of our retail butchers, demand that they be freely opened, irrigated with saline or sublimate, or scraped if necessary, drainage inserted and maintained, and dressings frequently changed. These wounds are always to be splinted ; and the temperature taken frequently, and watched. Or these wounds are opened wide, even to half the joint capsule, especially if the joint looks and acts suspiciously ; the joints are packed with plain or sublimate gauze and changed frequently. After the pus and granulations have largely disappeared, suture the incised edges of the capsule except for the admission of one large drainage tube and allow the wound gradually to close up. It is a rule to incise the joints of the upper extremity early ; and that they do better and repair earlier than those of the lower extremity.

Or a single penetrating wound is infected either at the time of accident ; or is probed or infected with dirty instruments and dressings, and treated by the closed method ; or the joint becomes infected from a wound in the bone or the soft parts near the joint. After three days or at the most four days from the time of infection, the joint becomes inflamed, red, swollen, hot, painful and tense, and there is a temperature with or without a chill. The wound edges

are often red and edematous. If the sutures are removed, the wound gapes, and purulent serum or pus exudes. Or if there has been a hemarthrosis and it becomes infected, these changes are more rapid and more accented, coming on in 24 to 36 hours. On opening the joint, all the symptoms of a purulent arthritis are seen to be begun. The synovial membrane is injected and lustreless ; and after three days are covered with granulation tissue, which goes on to invade the whole joint. The exudate, at first sero-pus, soon becomes turbid, thick and flaky with sero-fibrin and desquamated endothelium. The ligaments are swollen and soft, or become brittle, and split easily. The cartilages, at first opaque and dull, grow yellow and erode ; or they split off from the bone, leaving the bone exposed or covered with superficial caries. Or there is infiltration about the joint. Such a joint, left alone, may finally empty by fistulous opening ; and repair secondarily by osteo-fibrous substitution for the granulation tissue, by ankylosis. Or the joint becomes empyemic and the patient dies in 3 to 5 days of pyemia or septicemia ; or it becomes diffuse, and the patient is saved only by a high amputation ; or gangrene sets in, and the patient dies in 4 to 6 days. Treatment of these cases is likewise that of septic arthritis. Open the joint broadly, clear out the granulations, irrigate with 1-2,000 sublimate, pack and apply abundant wet dressing, and splint. Re-irrigate, pack, and dress the wound frequently. It repairs rapidly as a rule, the exudate gets less and less, and more watery, and finally ceases. Close the broad wound with deep and surface sutures, inserting drainage tube. Finally, remove drainage tube and begin massage of the joint. There is uniformly good repair and fair function of the joint, depending upon the age and general physical condition of the patient, and upon the particular joint and its condition.

**Dislocation,** or luxation, is an abnormal and permanent displacement of one or more bones of a joint. In *recent dislocation* there is slight displacement of the bone and rupture of the ligament, usually with accompanying disruption of the overlying soft parts. It is *simple* and without special tearing of blood vessels and nerves, rupture of synovial membrane, or fracture ; or it is *complicated* by any or all of these. It is *compound* if the joint is open. *Partial* dislocation or subluxation consists of partial displacement of the bone end from its socket, with or without partial rupture of synovial membrane. It is *complete* when displaced entirely without such glenoid cavity. *Old* dislocations are usually complete ones, unreduced, of long standing, one week to two years.

Occasionally we have a *diastasis* of vertebra and symphisis, arthrodial joints ; or of the mandible, a ginglymo-arthrodial joint. It is a simple displacement, scarcely constituting a dislocation. Or we have dislocation complicated by the tearing off of an apophyseal scale or of a malleolus, or with near-by fracture of the proximal bone or bones as in Pott's and Colles' fracture.

**Cause** of dislocation is largely *traumatic*, indirect violence aided by position of the part and relaxed muscle control. Or dislocation is *pathological*, due to inflammatory causes. Or it is *congenital*, due to defective growth of glenoid cavities.

*Recent* dislocations are due to force that is external or is derived from muscle spasm, especially when excessive. It is largely and almost purely a mechanical process ; a bony prominence or a dense ligamentous band constitutes a fulcrum, the bone a long arm, then with force and especially with rotation, the capsule is burst through at its thinnest point. Or some bony prominence such as the olecranon constitutes in extension a check point, then over-

extension relaxes the joint parts and causes a sprain ; or excessive, a dislocation. Or the ankle, in falls from a height, gives way at its inferior tibio-fibular ligament ; the articular surface of the calcaneum is driven between tibia and fibula, constituting a spread ankle ; or there is contusion and laceration of the articular cartilages only.

Dislocations occur as the result of abnormal muscular action, both active and passive, such as dislocation of the mandible from yawning, or chewing hard taffy ; the dislocation of the shoulder from tying a vail, "chinning" on a horizontal bar, or pulling out a sticking bureau drawer. Occasionally, a patient has the dislocation habit, due largely to loose capsules and flat glenoid cavities. Joints of limited function and unlimited requirements are oftenest dislocated, such as the shoulder, jaw and hip.

Dislocations take place largely in adolescent and middle life. Those of the upper extremity constitute about 90 percent of all luxations ; the lower extremity 5 percent ; the rest scattering. They occur in the proportion of one dislocation to ten fractures. Shoulder dislocation constitutes 50 to 70 percent of all ; men have three to five times as many dislocations as women ; and women have 80 percent of the jaw dislocations. Fracture of the humerus and dislocation of the elbow follow the same causes before twenty years of age as after twenty years cause fracture of the clavicle and dislocation of the shoulder.

*Old* dislocations are the result of pathological changes or more usually of neglect. There is obliteration of the old joint cavity and its ligaments and synovial membrane, and there is atrophy of the bone end and the formation of a fibrous false joint or nearthrosis. By periosteal irritation, there is new bone growth, that after a time becomes cartilage covered and enclosed in a fibrous capsule.

**Symptoms** of a recent dislocation are, subjectively, pain and loss of function; objectively, changes in contour of the part, the relation of the joint parts, and in the axis and length of the part. Aside from the more or less characteristic deformity, the marked symptoms are the dull nagging pain, that locates in the ruptured capsule and radiates down the limb, and the decided limitation of movement and loss of function. The limb is mechanically out of place, limp and useless; and any attempt at motion, beyond a certain variable point, causes pinching of capsule or cartilage and excessive prostrating pain. Comparison with the opposite joint gives readily the mechanical differences between the two joints. The bone end, or head, is felt in its new or abnormal position, especially if palpated while the limb is slightly rotated. There is pain wherever the torn capsule is pressed upon.

*Old* fractures seldom give the same general symptoms. There is little or no pain and usually only a small amount of limitation of motion. But there is usually a paralysis, due to pressure of the bone end or of new inflammatory tissue upon a neighboring nerve trunk.

Complications give their varying and added symptoms.

**Diagnosis** is a comparatively easy one. Care should be exercised however to make sure that there is no complicating fracture. A reduced luxation gives no symptoms, save a little pain, and is capable of accomplishing most of the movements of the joint; if only partially reduced, the joint is painful and limited in function; if fractured, there is no lessening of pain and no functional use after reduction of the dislocation.

**Prognosis** of recent dislocation is excellent, save for adhesions that are readily corrected and for loose capsules that are seldom remedied.

**Treatment** is the immediate reduction of the luxation, usually without an anesthetic, and immobilization of the limb, for from one to two days to three or four weeks, until the joint capsule is entirely repaired. Dislocation is largely due to over-extension. In reduction, use is made of fulcrum points, such as bone and accessory bands of the capsule, and flexion combined with rotation,—a sort of reverse method to the process of dislocation. It varies with each joint and will be discussed in Special or Regional Surgery. After reduction, or reposition, the limb is to be rendered immobile by bandaging or strapping, splints, or traction, or may require pegging.

Reduction is interfered with by spasm of the overlying muscles, by impaction in the narrow slit of the capsule, or by interposition of parts such as torn muscle or fascia. These are usually overcome by anesthesia, anatomical leverage and a little well-directed direct pressure, when the joint goes into apposition with an audible snap.

Massage is begun after the removal of the immobilizing apparatus, whether it be bandaging, strapping, splints or cast. Or if, as the dislocation is watched from time to time, there is evidence of fibrous ankylosis, more freedom is allowed, and active and passive motion is begun early.

In irreducable dislocation an arthrotomy may be necessary and is done with all aseptic precautions. Habitual dislocation is corrected by reduction and the wearing of a restraining appliance or harness that shall prevent over-extension. Occasionally pursing of the over-distended capsule is indicated and is a perfectly justifiable procedure. Old dislocations, within a period of two to four years, may often be forcibly reduced under an anesthetic; or they are left alone; or they are reduced by the open method, arthrotomy. Complicated by fracture, the dislocation is first reduced and then the fracture. The other complications are taken care of in the ordinary way. In compounded

luxation, there is first reduction, then suturing of the capsule and then of soft parts, all done aseptically. In these cases massage is begun early. Badly comminuted fracture and dislocation ordinarily demands resection and nailing. Or if infected, as is not infrequently the rule, amputation must be done.

**Pathological dislocation** is usually confined to the hip joint; is due to serous synovitis and distension of the capsule; or the joint parts are destroyed, incidental to arthritis; or the joint is deformed by joint disease, notably the arthropathies; or, as in about 70 percent of the shoulder cases of this type, it is due to muscular paralysis The correction, as well as the prevention of these cases, is largely orthopedic.

**Congenital dislocation** is largely confined to the hip joint and originates in the uterus, practically never after birth. It is caused by an anomaly of development in which the acetabular growth from the triangular cartilage is incomplete. The displacement is upon the dorsum. The correction is by orthopedics.

## TUMORS, GENERAL CONSIDERATION OF.

(*After Ziegler and Warren.*)

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A **tumor** is a new growth,—not due to inflammation or hyperplasia,—has no growth limit, and is without function to the body. It is atypical in that it differs from the surrounding tissue in which it develops, yet it follows types of human tissue. The tumor probably originates in overplus of foetal or embryonic cells, that remain latent until there is for some reason an increased or a decreased circula-

tion in a part. Such circulatory changes are usual at puperty, during pregnacy, in alcoholism, and follow irritation, traumatism and inflammation. Decreased circulation is not unusual at the menopause or on business retirement. Tumors develop singly, by a process of proliferation of the original tissue cells and of new blood vessels.

The causes of tumors is multiple. They may happen at any age, in either sex, and in all occupations and positions in life. They are said to be caused by both direct and indirect violence. The tumors of youth are usually those of embryonal or growing tissues; those of old age and adult life are found in formed or retrograde tissues. Tumors are not transmissible. They may be classified as those of local predisposition, or hereditary; of traumatic origin; those following inflammation, especially ulcer and scar tissue; and those arising from functional atrophy.

In the first or hereditary class are the tumors following the type of bone, cartilage, blood vessel, fibrous connective tissue and lymph node, and the multiform sarcoma. It also includes those misplacements of foetal tissue, as cartilage tumor in the kidney, and the like.

In the second or traumatic group, five to fifteen per-cent of all causes, are especially placed the malignant tumors, carcinoma and sarcoma; and also glioma, neuroma, myoma and lipoma. The trauma may be slight, such as cracks of the lip, nipple and anus; or simple irritation by chemicals or excretions; or severe, as bruising or crushing of the various tissues.

Third, or inflammatory, group includes more indirect traumatism and inflammation injuries; such as cancer of the skin from very slight irritation, cancer of the gall-bladder following gall-stone colic, or inflammation of the stomach and cancer. The frequent carcinoma of uterus, breast and liver are examples.

Under the fourth group may be included the atrophic changes, approaching senile life, as the cirrhous cancers of skin and of the various organs.

**Extension.** Tumors increase in size by interstitial growth, by infiltration and by metastasis. The growth of tumors, or their cell proliferation, varies with their location, their structure and their blood supply.

*Interstitial growth* causes displacement of the normal tissue of a part and sequent loss of function, and often causes pain and circulatory changes in the original tissue. There may occasionally be degeneration and death if the tumor-growth is rapid ; or only atrophy, when the process is of slow development.

*Infiltration* causes involvement of normal tissue, cavities and organs. There may be a sort of degeneration of a retrograde type in the normal tissue, but that is all. This extension is rapid, since both old and new blood vessels join in the process. Of such type is sarcoma.

*Metastasis*, by means of the blood vessels and the lymph channels, vessels and nodes, is a process by means of which the tumor-growth is carried rapidly to some far distant point, there to form daughter-tumors and multiplication of growth-sites. Carcinoma is an example of metastasis ; as is also recurrence of cancer in the scar tissue of the operation in removal of the same.

Tumors also suffer retrogression as well, and slough, ulcerate and necrose.

**Varieties.** Tumors may be roughly classified from an embryological standpoint as those of connective tissue type ; those of epithelial type, and composed of epithelial cells as well as connective tissue and blood vessels ; and teratomata, those made up of a still more complex structure and comprising foetal remains. Virchow from a purely anatomical standpoint uses the same grouping ; calling the first,

histoid, or one-tissue group; the second, organoid, of the type of stroma and cells; and the third, teratoid, being anomalous and complex.

Those of the *connective tissue* type simulate embryonic connective tissue in their mode of growth and are rich in cells. They comprise those simple tissue growths such as fibroma, myxoma, lipoma, enchondroma, osteoma, glioma, sarcoma and certain mixed forms; or certain others, types of tissues of higher development and function, such as angioma, myoma, neuroma, lymphadenoma and lympho-sarcoma.

Those of *epithelial* type, Virchow's organoid group, are composed of connective tissue stroma, giving foundation to epithelial cells. They are almost glandular in composition. They are adenoma, carcinoma, endothelioma, cystoma and its allied forms cysto-adenoma and cysto-carcinoma.

The *teratomata* constitute those tumors of normal tissue that exist at abnormal sites such as dermoid, foetal cysts, and congenital malformations of all sorts.

**Symptoms** are as varied as the type, site and growth of the various tumors. The symptoms are both local and constitutional. They may destroy the part; or drain the system through general involvement of its structures. In general they may be said to vary most, depending upon whether the tumor is malignant or benign.

The *malignant* tumors, carcinoma and sarcoma, grow rapidly by metastasis and infiltration. There is also a quasi-degeneration of the old ground-tissue, that causes an increased secretion. This secretion eventually finds its way into the body generally and produces a peculiar toxemia, that in itself eventually causes or helps to cause malnutrition, marasmus and cachexia. The patients have pain in the part involved, that is radiating, often lancinating and severe. There is tumefaction, loss of function and, as a

result of the degeneration, sloughing of the tissue and ulcer and necrosis. They speedily cause death.

The *benign* tumors, comprising all save carcinoma and sarcoma, grow for the most part slowly, usually interstitially or separately. They do not undergo metastasis nor leave their original site, though they may be diffuse. They do not poison the body nor cause cachexia. They cause inconvenience only as they grow too large or as they interfere with other tissues through pressure. And they cause pain, only as they press upon nerves and important organs or impede circulation. There is with them relatively slight tumefaction. Only rarely is there degeneration. There is seldom loss of function of the part, and death from them is rare.

**Diagnosis** is made positive by means of pathological examination only. Ordinarily however, these tumors choose certain tissues or organs of predilection and assume certain characteristic modes of growth by which they are known.

**Prognosis** of carcinoma and sarcoma is fatal save by early operation. As regards life the other tumors are seldom fatal, and most of them are operable at the convenience of the patient.

**Treatment.** Excise cancer early, widely and thoroughly. Excise other inconvenient tumor growths at the patient's convenience. Malignant tumors by operation give 75 percent of cures. Coley's antitoxin, prepared from mixed growths of strepticoccus, has caused many cases of inoperable cancer to become latent and has cured some cases that had otherwise been fatal.

## CARCINOMA.

*(After Professor J. Collins Warren.)*

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**Carcinoma** is a malignant tumor characterized by a stroma or network of connective tissue in whose areola or meshes are cell-masses resembling epithelial cells. Carcinoma invades the tissues both by infiltration and by metastasis. It keeps growing. There is infiltration of both cylinders and nest-cells, caused by rapid proliferation of the epithelial cells; and there is newly formed connective tissue stroma. By metastasis, mainly through the lymphatics, there are formed metastatic nodules; that at first are hard and small, but soon take on the characteristics of the original growth. In the skin it involves the malpighian layer and specializes as epithelioma. Either as carcinoma or as epithelioma there is apt at some time to be degeneration of its substance into mucoid, colloid, fatty or cystic forms. Occasionally carcinoma is multiple in its primary growth.

**Varieties.** The cells of carcinoma are large cells of the flat epithelial type, or cylindrical, or glandular, or giant celled. *Colloid* cancer as it occurs in the intestine, uterus and peritoneum is usually cystic and has colloid contents. *Encephaloid* or medullary cancer, whether of hematoid, osteoid or villous type, has little stroma of large mesh containing many cells and blood vessels. *Epithelioma* is composed largely of squamous epithelia and is characterized by its columnar invasion. *Melanotic* cancer is occasionally met with in man, and frequently in the horse; where it is very diffuse and very malignant, causes pigmentation in browns and blacks, and invades rapidly by metastasis. *Tuberous* carcinoma, comparatively rare, invades the skin in fibrous nodules.

*Scirrhus* begins, usually in the skin, as small fibrous miliary nodules, that enlarge into pea-sized or nut-sized nodules and nodular masses. These after a time become diffuse and often ulcerate and bleed. Scirrhus is composed of dense fibrous stroma and large nucleated cells. It is board-like when developed. On the chest, it is apt to invade the rib spaces early. It is of slow growth and is the least operable form of carcinoma.

**Cause.** Aside from the general causes already and always given for tumors in general, and cancer as well, there has been urged by many observers the special cause to be that of the *coccidium*. The coccidium is a so-called protozoan that is found in cancer of both man and animals, that inhabits the cancer cell, pushing its nucleus to one side. This organism consists of finely granular protoplasm, with nucleus not readily seen and without a cell envelope during its active stage. It invades the epithelial cell and encysts there. After a time it breaks away from the cell, sporulates, and passes out through the intestine to begin its life cycle anew by ingestion. Some observers have grown the organism in water and wet sand. Transplantation experiments and inoculations seem to disprove it as a cause of cancer.

**Occurence.** Carcinoma of the skin; a superficial small celled variety, not very malignant, is known as the *rodent ulcer*; and a deep seated variety, made up largely of squamous cells and prone to invade the lymphatics, has its type in *cancer of the* lip. It also occurs on the back of the hand, penis and scrotum,—where it is known as the *soot wart* of chimney sweeps.

Carcinoma of the breast,—the most frequent seat of cancer,—occurs at 40 to 50 years. The ordinary round celled or medullary variety is the most frequent and is often called *simple cancer*. Or cancer is *scirrhous*, the hard or

atrophying scirrhus, composed largely of fibrous tissue and few cells in few cell clusters, prone to ulcerate. Or rarely the cancer is colloid. In all these forms the axilla sooner or later is involved, the lymph nodes enlarge and press upon the axillary vessels and nerves, causing great distress. These tumors are stony hard, involving skin and nipple and underlying muscle and fascia, and are prone to ulcerate late. Term two to three years.

Carcinoma of the **uterus**; not infrequent in middle life or near the menopause of both nulliparae and multiparae; is vaginal, cervical, or corporeal. The vaginal variety is made up of squamous cells constituting *cauliflower* growths; the cervical, of glandular cells causing general *ulceration of the cervix*; the corporeal, varies from scirrhous to medullary type according to the varying stroma proportions, and causes *enlargement* of the whole organ, irritating secretions, and infiltration of all the neighboring organs.

Carcinoma of the **tongue**; consists of squamous cells; occurs about 75 percent of all cases of tongue cancer in man, at the age of 40 to 60 years; ulcerates and causes glandular enlargement in the floor of the mouth and about the submaxillary gland.

Carcinoma of the **esophagus**; consists of squamous cells, or of pavement epithelium type; occurs about equally in men and women, in the middle of the food tube; encircling it and causing its constriction and difficulty in swallowing; invading often the length of the tube and occasionally the bronchus; ulcerates into the tube, or late into the bronchus, causing strangulation.

Cancer of the **larynx**; largely squamous cells, rarely medullary or scirrhous; inside or outside the larynx; causing hoarseness, aphonia, ulceration, dysphagia and pain.

Carcinoma of the **stomach**; most common form of cancer; commonly cylinder cells, or medullary or scirrhous,

or rarely colloid ; usually near the pylorus ; apt to ulcerate : causes severe epigastric pain and gastric symptoms, from vomiting to death by starvation. Incurable.

Carcinoma of the **intestines** ; cylinder cells, medullary or scirrhous ; located at ileocecal valve, descending colon, or sigmoid flexure ; ulcerates early forming stricture, or infiltrates peritoneum matting the intestines ; and causing death by obstipation.

Carcinoma of the **rectum** ; squamous cells at the anus, and cylinder cells or medullary in the rectum ; externally ulcerates and involves all the adjacent parts ; internally grows luxuriantly involving the whole bowel, and soon breaks down to form a huge succulent ulcerous mass. This is the common cancer of the rectum. It causes death in two years, with excruciating pain and cachexia.

Carcinoma of **bladder** ; squamous cells or polymorphous ; ulcerates, invades the bladder walls, infects the inguinal glands and kidneys, and causes hematurea and death from pyelitis. Its course is very slow.

Carcinoma of **kidney** ; medullary, at times scirrhous ; occurrence, 70 percent in men ; infiltrates the kidney, causing nodular cortex ; it may retrograde and form cysts, or calcify. The spinal and peritoneal lymph nodes enlarge. Death is caused from uremia, shock or peritonitis.

Carcinoma of the **testicle** ; usually medullary ; may get very large and involve the skin. It is fatal in two years.

**Symptoms** are mainly the severe lacinating and sharp shooting knife-pains, day and night.

**Prognosis.** There are 75 percent of good results in early operation ; or following late operation there is recurrence and death in three years.

**Treatment.** Early operation. Arsenic in full doses.

## SARCOMA.

*(After Professor J. Collins Warren.)*

Sarcoma is a malignant tumor of embryonal connective tissue. The cells exist in such large numbers, and often of great size, as to mask the intercellular substance. They are well supplied with blood which is usually not confined in vessels but in spaces lined with epithelia. This tumor is especially malignant in its small celled and soft forms; it grows very rapidly and invades all tissues. It appears at an earlier age than carcinoma and has a predilection for skin, intermuscular septa, tendons, periosteum and subserous connective tissue. It compounds with tumors of the lymphatics and blood vessels, often forming pulsating tumors. It forms mixed tumors such as fibrosarcoma, myxosarcoma, and osteosarcoma. The cells are of various sorts, as small and large round cells, spindle cells, giant cells; and less commonly stellate and endothelial cells. The intercellular substance is fibrous reticulated, homogeneous reticulated, granular, or mucoid. The sarcoma undergoes degeneration at times, if its growth is not too rapid, such as fatty, caseous, cystic or hemetic, and there is ulceration and necrosis.

Varieties. *Encephaloid*, or medullary or pulpy, sarcoma is small celled, soft and rapid, and is the most usual form. *Giant celled*, or myeloid, sarcoma is a variety of the former containing an abundance of giant cells. *Melanotic* sarcoma is a spindle celled sarcoma with deposits of brown pigment in its substance. *Polymorphous*, or mixed, sarcoma contains a multiplicity of cell forms, depending on the location of the tumor. *Round celled* sarcoma is of two kinds; the small round celled, that is soft and is of rapid and malignant growth; and the large celled, that contains the

large round cells in greater proportion, but also spindle cells and giant cells. The *spindle celled* sarcoma, fascicular sarcoma or recurrent fibroid, is made up almost completely of elongated spindle cells.

The **cause** is that of other tumors, though there is undoubtedly a large embryonic and traumatic element.

**Occurrence.** In early sarcoma there is a time when the tumor seems to be latent and not malignant. The change is then made rapidly, or gradually. The nature of its tissue formation and the location of the tumor largely determines the malignancy of sarcoma. The greater the proportion of cells, the smaller these cells are, and the richer the circulation is ; the softer and the more rapid and malignant is the tumor.

Sarcoma of the **skin** : round and spindle celled and melanotic ; primary or secondary from irritation of warts and moles ; if deep, there is slow growth for years ; superficial, the tumor ulcerates or thickens, or the nodules disappear spontaneously ; occurs at 35 to 50 years.

Sarcoma of **bone** : originates in periosteum, or centrally.

*Central* sarcoma of bone is usually spindle celled or large celled or with small cell mixtures. It occurs at 20 to 30 years. Half the cases are of traumatic origin. The tumor is *myeloid*, mahogany colored, firm, undergoes fatty degeneration, pulsates, is of slow growth, and is metastatic in the lung. Or it is central and *spindle celled*, next most common of central sarcomas to myeloid, is nodular, greyish, firm, encapsulated, and of very slow growth. Or the bone tumor is central and *round celled*, or alveolar ; the tumors are globular, small and encapsulated. Or, they are very vascular or plexiform ; or alveolar and pulsating ; or becoming a blood cyst ; of rapid and large growth, metastatic in lymph glands, lungs, pleura, liver, kidney and bones, and malignant in two years.

*Periosteal* sarcoma ; occurs at 20 years, not encapsulated, malignant. They are *round celled* tumors, or alveolar, occur in shafts of large bones as spindle shaped swelling, more or less lobulated, malignant and only slightly metastatic. They develop in one and one-half years. Or they are *spindle celled*, develop in the epiphysis, especially of the tibia, and constitute a pear shaped swelling of slow growth. Or they are *osteoid sarcoma*, form bony plates and tend to outgrow their capsule and involve the glands by metastasis. Nearly 70 percent die despite operation. Or they are of the type of *chrondrosarcoma*. Or they constitute *epulis*, a red tumor of the gums, where unless the incision includes the periosteum and it is peeled off, the epulis is apt to return. Or the tumor is of the form of periosteal and myeloid *sarcoma of the skull*, where it involves bone and membranes, and may press on the brain. These are usually small growths of the parietal and temporal bones.

Sarcoma of **kidney** ; primary, not common ; soft medullary, or round celled, spindle celled, or stellate celled ; large tumors that degenerated into hemic necrosis or cysts ; or are myxosarcomata, or angiosarcomata.

Sarcoma of **bladder, stomach** and **intestine,** rare.

Sarcoma of **uterus** ; occurs in the mucous membrane of the cervix or body ; spindle celled or round celled ; lobulated or papillary growths of cervix ; or infiltrating the body, are soft and medullary, and form very large tumors. It is not especially metastatic. It develops in 10 years, in adult life, and usually is not curable.

Sarcoma of **testicle** ; spindle celled and round celled ; more common than carcinoma ; is painless and rapid, metastatic, occurs in children and adults, and last two years.

Sarcoma of **brain** ; is primary and constitutes fibrosarcoma ; or is secondary, gliomatous or polymorphic, and undergoes fatty degeneration.

Sarcoma of the **air passages**; involves the tonsil, the larynx rarely, the nose not commonly, the naso-pharynx forming fibrous polypoids, the palate either very early or late in life, the pharynx only occasionally; is usually of spindle celled variety or fibrous, and is of small and slow growth.

Sarcoma of the **breast**; round celled and medullary, or striped spindle celled, or alveolar; and accordingly soft fibrous or firm. It occurs first just below the nipple as a spindle celled tumor and the most common variety, and becomes cystic. Or it appears at the upper and inner quadrant as a medullary type of tumor, and becomes large and globular. Sarcoma of the breast occurs early, at 10 to 50 years, or more usually at 30 to 40 years. The skin is movable and normal. The tumors are large and malignant and of rapid growth. The nipple is not involved and retracted as in carcinoma, nor is the tumor so apt to be metastatic, early, in the lymph nodes. The round celled tumors develop in four to five years; the spindle celled, or cystosarcoma, in seven years; the giant celled in ten years. Good results follow operation and cures are established if there is no recurrence in four years. These tumors are not especially painful.

**Lymphosarcoma**, Hodgkin's disease; enlargement of lymph glands and diffuse infiltration of tissues throughout the body; occurs 75 percent in man; often infected with colon and pus cocci; begins in cervical glands and invades serially the axilla, groin, retroperitoneal spaces, bronchi, mediastinum and mesentery; metastases common; possibly due to a protozoan or a toxin which it develops and which causes degeneration changes. Coley claims 20 percent of cures in this inoperable tumor-disease by using

the toxin of the dead streptococcus and bacillus prodigiosus mixed, with their soluble products sterilized an hour at 135°. Arsenic is especially valuable.

**Symptoms** of sarcoma are variable. There is not much pain, save in rapid bone and breast tumors.

**Diagnosis,** to be differentiated by pathological examination. Alveolar types especially simulate carcinoma.

**Prognosis** is fair for operable cases. There is far less metastasis than in carcinoma. Osteosarcoma is always very grave.

**Treatment.** Operation early, or amputate high in osteosarcoma.

## BENIGN TUMORS.

(*After Professor J. Collins Warren.*)

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The **benign tumors** as a rule are those that do not undergo metastasis nor recur after operative removal. They vary much in general characteristics, in location, and are often complicated in structure. Many of them, after existence for a long time as benign growths, change their anatomical structure and become malignant. Such are the fibroma, myxoma, chondroma, osteoma, angioma, lymphadenoma, adenoma and cystoma. Some of these tumors seem to be of traumatic origin, such as irritation; while the bulk are congenital or embryonal. These tumors are excised when they cause pressure symptoms or they may become of malignant type.

**Fibroma** follows the type of fibrous tissue. It is found complicating all other tumors.

*Hard* fibromata are composed of much dense fibrous tissue with few cells and blood vessels, or they become cystic through degeneration. They exist mainly in the skin, generally as multiple fibroid, or fibroma molluscum, as nodules, or diffuse; or as keloid, or scar-tissue tumor, upon the face and neck; or as a pathological part of elephantiasis, of the scrotum and extremities; or as fibrous polyps of the naso-pharynx.

*Soft* fibromata, less fibrous tissue and more cells; are found in the subcutaneous skin, intermuscular septa, periosteum, and even in bone.

**Papilloma** consists of fibrous connective tissue, arranged in trunk form, branching out as it rises from its base, and a few flat epithelial cells, arranged compactly at the branch ends. It is a tumor of adult life and is found on skin and mucous membrane.

*Hard* papilloma, wart-like, occurs in muscle, nerve, nose, larynx, urethra, vagina, and on the labia, vagina, and cervix of the uterus. It is especially apt to follow the irritation of these parts by acrid secretions. It is permanent, or disappears with cleanliness.

*Soft* papilloma, of villous type, is found in the stomach, duodenum, colon and bladder, and follows the irritation of chronic catarrh of these organs, and may disappear with a clearance of their mucus.

**Myoma**, or tumor of muscle-tissue type. It is not common except as *leiomyoma*, the fibromyoma of the uterus, that follows all chronic changes of that organ.

Leiomyoma consists largely of plain muscle fibers, and occurs in uterus, intestine and urinary organs.

*Rabdomyoma* is composed of cells resembling striped muscle. It is rare, and constitutes the striped spindle celled sarcoma of the heart, kidney and testicle.

**Myxoma** is composed of mucous cells, or embryonal tissue that is capable of forming adipose tissue. It is a tumor of middle life.

*Round celled* myxoma has the cells held in a transparent intercellular substance.

A *polymorphous* form having elongated cells, spindle cells or stellate cells, anastomosing with each other, tends to mix with fibrous, medullary, sarcomatous and neural tumor forms.

**Lipoma,** adipose tumor, consists of fat cells, slightly larger than the normal fat cells, held together by a reticulum of fibrous connective tissue. These tumors are soft and lobulated, are found upon the neck, shoulders and back, and rarely upon palms and soles. They have the peculiar habit at times of shifting their position, subcutaneously. They occur singly, more often in women, and are mainly confined to middle life. They are circumscribed; or they are diffuse as in the double chin, pendulous breasts and abdomen.

**Glioma,** composed of cells of neuroglia type contained in a reticulum of fine glistening fibers, occurs in the brain, or as an eye tumor in children, or in the cerebellum as a

ganglial formation. Probably the cavities of the cervical cord that cause syringomyelia, in the posterior horns and near the posterior commissure, are the result of the degeneration of an embryonal tumor, similar to, if not, glioma.

**Chondroma,** or enchondroma, cartilage-tumor, follows the type of hyaline cartilage and mixes with osteoma, sarcoma and fibroma; or, in combination with periosteal osteoid, frequently is recognized as osteosarcoma. As *ecchondroma*, cartilage-tumor rising from cartilage, it constitutes one form of joint bodies. Chondromata are often found as small tumors in visceral walls, as in the kidney.

**Osteoma,** bone tumor, is familiar in the exostoses of purulent periostitis, and as enostosis in the nodular sequestrum of caries.

*Hard* osteoma constitutes the ivory exostoses of osteosclerosis.

*Soft* or spongy osteoma occurs on the long bones, pedicled, is of medullary type, and usually rises from the epiphyseal line.

Osteoma grows from periosteum, cartilage, medullary membrane, or is independent of any of these sources.

**Neuroma,** nerve tumor, is composed in part of nerve fibers but largely of dense fibrous tissue; it exists singly or multiply, and when single causes much pain. It is often compounded with sarcoma and myxoma, and then becomes of malignant type; or with fibroma, and is benign.

*Plexiform* neuroma is a comparative infrequent form, situated in the skin of the neck near some crease, is nodular, the skin is hypertrophied and generates coarse hairs.

*Sensitive* neuromata, of amputation stumps, are found as bulbous ends of the nerve trunk, lying free or caught in the cicatrix scar. They are exceedingly painful and require excision. There is increase of interstitial fibrous tissue and a dense fibrous outer coat.

**Angioma,** blood vessel tumor, is superficial, or is a tumor of the subcutaneous cellular tissue.

Superficially it comprises *plexiform angioma*, *telangiectasia*, or *nevus*; or bright red "birth-marks," "port-wine marks," or "spiders."

Or subdermal, the tumor is more developed, bluer, the skin hypertrophied and raised, often hairy, and the underlying pulsating blood vessels empty on pressure. Of this class is *cavernous angioma*, *varix* and *cirsoid aneurism*.

These tumors are to be eradicated, early in youth, with the galvanocautery, pacquelin or with the actual cautery. The resultant burns heal readily without scar.

**Lymphangioma,** lymph vessel tumor, comprises *simple* diffuse dilitation of the lymph vessels, as in elephantiasis; or *cavernous*, of the face, trunk and extremities, where it is easily mistaken for a lipoma or sarcoma; *cystoid*, as in hydrocele of the neck.

Lymphangioma is rare and congenital; or, rather let us say, it is rarely diagnosed because of its normal color and softness.

**Adenoma,** gland tissue tumor, consists in the formation of acini or tubes as in normal lymph nodes. It occurs in the skin, mucous membrane, brain, kidney, liver, and as

minute tumors in the sweat glands of the face. The tumors are also mixed, fibrous, myxomatous and cystic ; or form the polypi of the nose, intestine and rectum. They are especially wont to become malignant, or at least to combine as adenosarcoma and adenocarcinoma, and for this reason demand excision early.

**Cystoma**, a cyst of new growth, hyperplasia, often warty inside and containing mucus or gelatine. They are familiar as ovarian, glandular, adenomatous or papillary cyst ; as mucous cyst or ranula ; as atheromatous cyst of the hyoid ; as dermoid cyst ; or as more simple serous and hematic cysts in various parts of the body, often subcutaneous. If they cause pressure and are suspicious, as in the breast, they are to be punctured or aspirated. Or they occasionally become infected, and require puncture and perhaps curetting.

## PREPARATION FOR OPERATION.

An **operation** is a process of mechanical interference to remedy a disease or an injury.

Such operation may be *bloodless*, such as giving a hypodermic or an enema, catheterizing, cupping, leeching, blistering or cauterizing.

Or, as usually considered both by the laity and the profession, an operation constitutes a *surgical act*, necessitating aseptic preparation, anesthesia often, the use of cutting instruments and subsequent hemostasis, following as full diagnosis as is possible by all modern and exact methods. Or, such surgical operation is done in order to

make an exact diagnosis, as is not infrequently done in complex disease of abdominal organs. Or, such operation is done subsequent to full repair of a disease or injury, as in contracture, ankylosis; or in incomplete and slow, or inefficient, repair for cosmetic effect.

Operations demand talent and tact. The surgeon must master his anatomy and his anatomical findings; he must be exact in his asepsis, his reasoning and his touch; he must be steady, and be devoted to his work, and ready. His technique must be perfect and easy.

The **indications for operation** are manifold. Since no operation is free from danger to life, it is customary to divide operations into those of necessity and those of convenience.

An *operation of necessity* constitutes one in which the patient's life is in immediate or imminent danger without radical surgical interference. Such an operation is to be made as soon as diagnosis is reasonably assured and upon preparation of the operation field.

An *operation of convenience* is done for benign tumors, for diseased conditions at a dormant period between acute attacks, for chronic conditions and the like. There is no special urgency as in correcting a destructive disease process.

Among the indications for operation, then, are the necessity or the expediency of the case; either as regards the surgeon and his assistance, or the desires and wishes of the patient and his friends. The patient should be reasonably sound in body and in strength. There should be no disease of heart, lungs or kidney. The patient shall give his full consent to the performance of the operation; or in lieu of his consent, that of a wife, child or parent should be obtained, in writing if thought necessary.

The **contra-indications** for operation are largely those of age and condition. Atheroma, endocarditis, nephritis,

bronchitis, senility, unsound reason, delirium, shock and hyperpyrexia usually contra-indicate. Multiple operation, or operation in which there are operation accidents, must be delayed or done in steps or at intervals in order to sustain the patient's general strength and abet his repair. No operation should ever be undertaken under promises of definite repair processes. Neither should an operation be had where the patient or any near blood-relative refuses to grant full permission for operation ; or, in opposition to such refusal, only after consultation of capable surgeons and perfect unanimity of the consultants that the patient's life is in immediate danger without the operation and that he may be benefitted with it.

**Operative Prophylaxis.** An operation having been decided upon, a clean, warm, well ventilated and well lighted room is chosen in which to operate. It shall be large enough for a small operating table, for one or two small stands and for the surgeon, his assistants, and the nurses. No friends are to be present. Means of artificial lighting should be looked out for. Rubber sheets may be provided to lay across the patient over the blankets. Drainage of solutions is easily provided by means of a Davidson inflated ring pad. Any solid table can be used for the operation. By preference, a table at least three feet high, six feet long and not over two feet broad is to be desired. This is padded by a folded blanket, covered by a rubber sheet and a linen sheet as desired, and furnished with a pillow. Sheet and blankets to cover the patient are ready at hand. The patient is dressed in an ordinary night suit, or a special operation suit of flannel is used. Basins of solutions and instrument trays are placed upon the stands, pitchers of hot water and additional solutions are placed near at hand. Bundles of aseptic towels and cheese cloth

pads for sponges are to be provided in abundance ; and dressings in readiness.

The patient, the night before operation if possible, is given a full bath and a thorough laxative and put in a clean bed that he is to occupy. The operation field is shaved, scrubbed, and a soft soap poultice applied. The next morning an enema is given if needed ; and the patient, without breakfast, is ready for the anesthetic and the operation.

The surgeon and his assistant, and the nurses, are to strip to their shirt sleeves ; roll the sleeves to the elbow. To clear the skin and especially the nails from their many bacteria, the nails are carefully pared or filed smooth, but not short, and dry cleaned ; nails, hands and arms to the elbow are soaked and scrubbed with soap and hot water for five to fifteen minutes. The hands are dried, the nails are again carefully cleaned, and the hands again soaked and scrubbed. The hands and arms are then cleared with alcohol and then with ether, and then are allowed to soak and be wrung in sublimate solution 1-1,000 or 1-2,000. They are then ready for operation.

Or the double cleaning and scrubbing process is gone through as before. The hands are then rinsed and well rubbed with calcium chloride and sodium carbonate about equal parts. This forms a creamy sort of paste, sets free nascent chlorine, and at once bleaches, clears and cleans the hands. They are then upon rinsing, and with or without the use of the sublimate solution, ready for operation.

The instruments are made germ free by heat ; either by baking, by boiling, or by steam. A usual procedure is to boil the instruments for ten minutes, once thoroughly cleaned by scrubbing, in a one percent solution of sodium carbonate in water. This prevents oxidation or rusting of the instruments and farther aids the aseptic process. The

instruments are now rolled out into their tray, covered by a wet towel and are ready for use. Or they are placed in phenol 1-20 till time for the operation, when the solution is diluted to 1-50, or 1-60.

The dressings are steamed, previous to the time of operation ; and the water is sterilized by boiling.

The principles of **asepsis** strictly apply to each and every step of operation work. Any break from aseptic procedure or technique destroys the value of the whole work, whether it be caused by the surgeon and his preparators, the nurse and her preparators, by the friends or the patient, or by accident. The sum of all the mischief done is the result of the least possible infection in any line of technique, whether in preparation of the patient, or during the operation, or in after-treatment or dressings. Primarily this asepsis is accomplished ; first, by making the patient, the operation field, and the patient's surroundings, clean ; next, by having instruments, sponges, ligatures and sutures, and dressings, clean ; by establishing cleanliness in the surgeon and his assistants ; and lastly by assuring no possibility of infection by accident.

Even at best this asepsis is only relative. Many bacteria are not diluted and washed away, nor killed by the chemical antiseptics. This is shown by tube cultures taken before, during and after operation. The bacteria seem to thrive and to increase. Scrubbing, soaking and dilution accomplish much. Otherwise phagocytosis, the natural immunity of the tissues, the bacteriocidal action of the normal alexins, and the presence of saprophytic bacteria,—without traumatism of the tissues, and with absolute hemostasis,—accomplish the rest.

# ANESTHESIA. ETHER. CHLOROFORM. MIXED NARCOSIS. NITROUS OXIDE. SPINAL ANESTHESIA. LOCAL ANESTHESIA.

**General anesthesia** consists in the administration of some inhalant, or anesthetic, that produces loss of consciousness, insensibility to pain, and diminished or relaxed muscular action. It is made use of for operation or diagnosis. The anesthetics generally used are ether and chloroform; sometimes nitrous oxide and A. C. E. mixture. The action of these general anesthetics is to depress the general nerve centers. Ether is supposed to depress especially the respiratory centers, and chloroform the cardiac centers, in cases of profound and fatal narcosis. Chloroform is used largely in children, in cases requiring short anesthesia, and in acute inflammations of the bronchi and kidney. Ether is used in adults, sparingly in senility, and in cases requiring prolonged narcosis. In use of either anesthetic, especially ether, in alcoholic, nervous or hysterical patients, the narcosis may be hastened, allayed and prolonged by a preliminary hypodermic injection of morphine gr. ¼ and atropine gr. 1-100. This also lessens the after-sickness and dries the bronchial mucus and saliva.

Ether was used as an anesthetic as early as 1846, chloroform in 1847, and nitrous oxide in 1800 and again in 1844. Before their advent and safe use, recourse was had to opium, cannabis and conium. The last named drug is a muscular paralyzant and not a narcotic nor an anesthetic; and in fact the use of none of these drugs was in any way entirely satisfactory. Ether is used largely in America and in temporate climates. Chloroform is used almost exclusively in the tropics, and in England and her colonies.

**Examination of the patient** is always made before the administration of an anesthetic. The heart and lungs are thoroughly gone over, if possible a half hour or hour beforehand ; the urine is examined for albumen and casts ; the mouth is cleared of any foreign bodies, such as gum, loose or false teeth, at time of administration. Inquiry is made as to the emptiness of the stomach and bowel. Note is made of the pulse rate, volume, and general character ; of the pupil, the complexion, and quality of the general circulation. Stock is taken of the patient's general calm, or his nervousness, and a few casual inquiries are addressed to him both for information and for his assurance and confidence.

**Narcosis phenomena** are those, first, of beginning loss of sensation, then loss of volition and of motion due to paralysis of the centers. This is usually preceded by a stage of stimulation and excitement. The invasion of the centers begins in the cerebral lobes, then successively advances upon the cerebellum, the spinal cord, and finally the medulla, when reflexes are lost. The loss of motion begins in the muscles of the back ; from there invades the extremities ; and appears last in the cornea, which is rich in nerves and closely connected to the general centers. A patient is fully under the anesthetic when all voluntary and reflex motion is lost, and only the automatic respiratory and cardiac action is maintained.

**Administration of ether,** or etherization, is accomplished by means of an inhaler or mechanical device for the efficient dilution of the ether for inhalation. The inhalers most in use are the cone, Allis', and the Clover. The cone is a flattened cylinder made to fit the face of the patient, has stiffened sides, and is enclosed or partially closed at the

top. It is rapidly made, convenient and hygienic. The Allis' inhaler is unhygienic as ordinarily used, is a metal cylinder so as to be capable of threading with strips of gauze bandage, covered with leather or rubber, and is capable of closure at the top. The Clover is a mechanical device for diluting ether, the exhaled air being received in a thin rubber bag, attached, to be rebreathed and to aid narcosis by asphyxia.

The cone saturated with ether is placed over the face, the nose and mouth being enclosed in its aperture, and the patient is instructed to take long, deep and regular breaths. The effect of the first irritation of the respiratory apparatus is avoided by gradually approaching the face with the cone, and by having the room perfectly quiet. The patient may cough, cease breathing, strangle, or wish to expectorate, in which case the cone is removed for a second, and then gradually approached again. Any cyanosis or too widely dilated pupil will indicate too little admixture of oxygen ; as a sharply contracted pupil marks too rapid inhalation effects of the ether. The finger is kept upon the radial, facial or the temporal pulse, and the effect of the ether upon both the pulse and circulation is closely watched. Full narcosis is marked by full muscular relaxation as indicated in the arm, the eyelid, or the pupil.

Ether is volatile, inflammable and explosive. In giving it, its vapor drops to the floor. It may explode if properly admixed with air ; and for this reason no flame, cautery or fire-place should be in the anesthetizing room. Ether is presumably safer as an anesthetic than chloroform, in that it produces less cardiac depression. It is often irritating to the bronchi, causing frequent spasm of respiration. At times it causes such marked suspension of respiration that it demands a change to chloroform or a hypodermic of morphine before narcosis is accomplished. In cases of sus-

pended respiration, or vomiting, it is convenient to have at hand a mouth gag, tongue forceps, or a needle and heavy silk suture, as the tongue relaxes and drops back, causing a mechanical interference with respiration. Convenient stimulants and a set-up hypodermic needle should be at hand in case of serious cardiac depression from any cause.

Etherization is divided into three stages. They are reversed in recovery from the ether, either during or at the end of the operation. The stages are those of volition, excitement and toleration. In the primary stage, or *stage of volition*, there is increase in heart's action, pulse and respiration. The face is flushed and the patient mutters or talks or moves slightly. The muscles relax finally and there is a short period at this time when the patient is anesthetic. This constitutes a period of primary anesthesia during which rapidly executed and slight surgical operations may be done. Or, the anesthesia rapidly passes into the *stage of excitement*. The patient is still more flushed, or not ; the pulse and respiration are more high-pitched, or are steady ; but the patient proceeds to laugh, cry, yell, or to move or fight, and has to be restrained. Soon the patient begins to breath regularly, the pulse is regular, the skin moist and cool and the patient snores. The muscles now fully relax, and the jaw is easily controlled. This constitutes the *stage of tolerance*. It has taken from 15 to 20 or more minutes to accomplish ; and it may be maintained for one to three hours if necessary, with more or less interruption.

Ether kills by both asphyxia and syncope, so that both respiration and pulse are to be watched. The first is largely indicated by the widely dilated pupil and the slow returning circulation of the face or ear lobe when pressed by the finger. Cardiac depression and failure are marked by the

pin-point pupil, occuring suddenly, and the blanching of the face and cold moist skin surfaces.

**Administration of chloroform** is made by means of a folded handkerchief, napkin, soft towel ; or best by means of an Esmarch inhaler. This consists of a wire frame covered with some light cotton material, which is placed over the patient's face and upon which the chloroform is constantly dropped from a bottle. To prevent possible "burning" or blistering by the chloroform (erythema), the face is well oiled with coca butter or vaseline.

The first effect of the chloroform vapor, if condensed, is a sweetish taste, burning and stifling. For this reason at first, it is dropped singly and infrequently ; then more and more frequently and liberally as narcosis proceeds. The stages are not so well marked as in ether narcosis and are of much shorter duration. There is also greater danger of cyanosis from crowding the anesthetic ; in which case either remove the inhaler, or cease to drop the anesthetic upon it, or make sure that there is no mechanical obstruction to breathing. Properly given, the patient takes the chloroform, diluted to about five percent, quietly and regularly and in a very short time, five to ten minutes, passes fully under its influence. There is greater danger, with chloroform than with ether, of bad effects ; the changes are more rapid, and abruptly arrived at. The face and pupil are to be carefully and constantly watched for signs of overgiving, as well as for too little narcosis. Especially in children is there an occasional stoppage of respiration and cyanosis ; whether from irritation of the inhalant, or due to dropping of the epiglottis, or to the presence of vomited food and secretions in the pharynx. The inhalant is stopped for a moment, to be begun again carefully and slowly. Or there

is heart failure, syncope, or collapse ; the face pales, becomes blue and cold, the pupil dilates widely, the finger nails are blue, and the heart's action is irregular or interrupted. With children, the mechanical action of suspension, head downward, immediately clears up these unfavorable symptoms ; in adults, the head may be lowered or dropped. But, when the anesthetic is begun again, it must be pushed with care, to avoid any recurrence of these untoward symptoms. Fatal syncope once begun usually terminates abruptly, as in the stage of excitement, with stoppage of the heart and continuance of the respiration ; or it occurs during or at the end of anesthesia, and is regularly and slowly progressive to a fatal termination. It occurs especially in fatty degeneration of the heart and the arteries, as in the atheroma of old age. Or respiration becomes more and more shallow, and fails, while the heart's action continues.

With chloroform more than with ether it is necessary that the room be quiet and that the patient be undisturbed while giving the anesthetic ; and, especially, that his body be prone and his head low ; and that the anesthetizer be always on the watch for unfavorable symptoms and conditions, and know how to handle them immediately. If necessary, both anesthesia and the operation are to be interrupted and attention paid only to the resuscitation of the patient. Artificial respiration is of the greatest use. When there is a vigorous open grate fire in the room, chlorine is liberated and becomes very irritant, both to the patient and the operator and the assistants.

**Death from anesthesia** is usually due to one of two causes ; the specific narcosis of the inhalant, acting upon the centers and depressing them ; and also to asphyxiation, causing decrease of oxygen in the blood and farther depression or irritation of the centers. There is *cardiac failure*,

due to profound depression of the cardiac centers acting through the vagus upon the cardiac ganglia, causing inhibition ; or due to direct irritation of an already mechanically weak, fatty heart and atheromatous vessels. Or, there is *respiratory failure*, due in the one case to reflexes transmitted through the fifth cranial nerve, stimulating the vagus, and causing cessation of breathing and slowing of the heart ; or there is depressed shallow breathing secondary to the cardiac depression. The pupillary changes are at the same time effected, through sympathetic irritation or paralysis of the third cranial nerve, through anastomotic branches from the pharynx. On autopsy, there is found dark fluid blood, some crenulation of the red blood cells and granular degeneration of the nerve centers.

The **A. C. E. mixture,** or alcohol, chloroform and ether, in proportion of one, two and three parts respectively, is frequently used by certain surgeons. It is administered in the same manner as ether with all the precautions of chloroform narcosis. It has no advantages over either anesthetic, or the sequential use of both chloroform and ether.

**Nitrous oxide** is used largely by dentists and occasionally by surgeons for short operations. The condensed gas is contained in small iron cylinders and is liberated and given by means of an attached face mask that mechanically dilutes the vapor with air. The effect simulates to a certain extent asphyxiation ; and narcosis is usually complete while it lasts. It is rarely fatal. The patient loses consciousness after inhalation for one to three minutes, the

anesthesia lasts for one minute ; or may be prolonged for a half hour or hour by means of modern apparatus.

By means of a chamber in the mask, either ether or chloroform may be combined with the nitrous oxide blast, and combined narcosis effected. Exceedingly good results have been gotten by this method.

**Spinal anesthesia**, or Bier's lumbar puncture, is of more or less recent development, and is obtained by the following method. The patient is seated or laid upon his side with the back semi-flexed. On a line with the fourth lumbar spinous process and a little to the left of it a fairly large hypodermic needle is inserted through the ligamentous structure of the lumbar enlargement of the cord. A drop of the cerebrospinal fluid is allowed to appear in the base of the needle or to drop away. The barrel of the needle, containing twenty-five minims of a two percent sterile cocaine solution, is fitted or screwed fast, and injection made slowly, drop by drop. The needle is then withdrawn and the puncture closed by pressure. In a few minutes anesthesia begins in the lower extremities, usually bilaterally, and extends in 15 to 20 minutes to the pubes, to the diaphragm, and exceptionally to the chest, clavicle and eyes. The patient remains conscious throughout. There are great individual differences as to its effect, and often marked ideosyncrasies, as indexed by profound nausea and vomiting, by vertigo and headache, chills, disturbances of circulation, paralyses, and rarely by collapse and death. The marked vomiting and the brevity of the anesthesia are the main objections. Anesthesia continues for a quarter, a half, or a whole hour, or longer, but there is no way of predetermining it.

This method of anesthesia is still in process of development and is as yet unsuited to general use.

**Local anesthesia** consists in the injection into the skin, or the application or spraying of some substance upon mucous membrane or other tissues, whereby there is absence of pain and sensation in whole or in part.

*Phenol* in small quantities in one-half to two percent solutions may be applied to mucous membrane or injected into the tissues. It causes thrombosis and anesthesia, and may be absorbed and cause poisoning. It can be applied to the skin in five to ten percent solution, or pure, causing some numbness and not unusually burns. It is little used except in extraction of the teeth.

*Ethyl chloride* is a volatile liquid, that is exhibited in small bottles with a mechanical release. The warmth of the hand causes the expansion of the gas and a spray of fluid to be thrown upon the part to be anesthetized. Here, the rapid expansion causes freezing of the tissues and anesthesia. It is of much use upon skin surfaces, especially in the surgery of minor abscesses, localized cellulitis and boils. Freezing occupies one-half to three minutes, depending upon the depth of the process. Defrigeration occupies a half minute and is marked by return of sensation and some prickling. Ethyl chloride does not effect deep tissues, as evidenced by the pain of abscess puncture, although all the superficial structures are entirely anesthetic. It is a valuable aid in minor surgery.

*Ether spray* is made use of, but is not so satisfactory as ethel chloride.

*Cocaine* and eucaine, and especially their salts, are used to produce anesthesia of mucous membrane by simple application in four to ten percent solutions. Or, it is given by

hypodermic. All cocaine solutions should be sterilized by careful heating, and not more than a grain should be injected in the tissues, without release, for fear of cocaine poisoning. It is a most valuable adjunct.

*Adrenalin* is employed as an anesthetic and vasoconstrictor of mucous membrane, either used alone in neutral solutions, 1-1,000, or in combination with five percent of chloretone.

*Ice* and *dry heat*, as well as *pressure* or pinching, are made use of to cause partial and temporary analgesic effects. Similarly, hypodermics of ice water are injected over irritated nerve trunks to stop neuralgic pains; as does the pacquelin cautery cure those of sciatica.

Or, *regional anesthesia* is produced by applying a ligature to an extremity above the point of injection and operation. Hand and foot amputations even may be done in this way.

Or, *infiltration anesthesia* is accomplished by injection of large quantities, two to four drams, of dilute solutions of cocaine or other alkaloids. Advance the needle only after the slow injection causes a pale blotch of edema to appear. No ligature is needed. The parts usually return to normal rapidly after operation.

## CONTROL OF HEMORRHAGE. SAVING OF BLOOD. METHODS OF HEMOSTASIS. TRANSFUSION METHODS.

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**Control of hemorrhage** is directed, first, to the temporary stoppage of the bleeding and the saving of blood quantity, generally, or at least to the maintenance of supply to important organs. Second, steps are taken to effect

permanent control of bleeding and repair of the blood vessels.

**Saving of blood** is effected through artificial ischemia of a part, by elastic compression, or compression by digital pressure, screw clamps or improvised tourniquet. Wound hemorrhage is otherwise topically stopped by plunging the finger or fingers in the wound, by dressings and pressure over the wound, or by packing the wound or tamponade.

Esmarch's artificial ischemia is made use of in cases of loss of considerable amounts of blood following unarrested hemorrhage ; either primary at operation or through accident, or secondary to suppuration. It is also made use of in the collapse following tedious operation. It consists in spirally binding or winding an extremity from its tip to base with an elastic rubber bandage. The base is then compressed by an Esmarch bandage or by rubber tubing sufficiently tight to prevent arterial return flow. The rubber bandage is then removed from tip to base. The extremity is thereby rendered bloodless, for operation if need be, and the blood is emptied into the portal circulation and central circulation. One or more limbs may be rendered ischemic, to the betterment of both the general condition and the general tonicity of nerve centers. Such ischemia may be maintained for two hours, without damaging the tissues of the limb. By alternating limbs, the severe collapse and other symptoms and lesions of acute anemia may be tidied over for considerable periods, or until reaction takes place.

Elastic compression, in the form of elastic rubber bands or tubes, controls afferent arteries until further procedure can be undertaken. The inelastic tourniquet serves the same purpose, especially if padded over the arterial trunk, but it is not so efficient and it causes more traumatism of the tissues.

Screw clamps are used especially in treatment of aneurism, where long continued pressure is needed. Likewise digital pressure is made use of in aneurism, is more delicate, but is difficult to maintain for long periods. It is moreover the best method of hemorrhage control, in skilled hands, for shoulder and thigh amputation and exsection.

Long compression by any of these methods is apt, especially in annular compression, to cause parenchymatous hemorrhage or oozing into the tissues, gangrene, paralysis and infection. The elastic methods, however, are capable of long maintenance ; they are safe, can be applied without special anatomical knowledge, are portable, and can be applied to almost any artery or bleeding point.

**Hemostasis** by means of the finger or pad pressure or tamponade should be done aseptically ; but often time does not permit, and life is of more import than question of infection.

Other methods of hemostasis are clamp and ligature, ligature en masse.

A bleeding point, or spurting artery, or welling vein is caught fully and firmly by an artery clamp, or hemostatic forceps. If tied at once, the ligature of sterile catgut is carried around the nose of the forceps to include as much tissue as possible and is firmly tied in a surgeon's knot ; care being taken to free the nose of the forceps and not to leave the ligature loose upon the tissue. Or, in large arteries, one or more separate ligatures of braided silk are carried about the artery at a quarter inch interval and tied securely. Or, in the case of smaller arteries, thrombosis is effected by clamping tightly and leaving to the end of the operation ; and then simply freeing the tissues, with or without torsion.

Or, in cases of hemorrhage deep in the tissues, capillary oozing and the like, the control is made by carrying a curved needle, or aneurism needle, with threaded ligature down deep in the tissues, and tying. Or the bleeding points are caught in broad-nosed forceps, and these are left in situ for one to four days. Of necessity such a wound, generally septic, must be left open and packed.

The cautery is of use in operations upon the liver, spleen and kidney, to prevent hemorrhage, but there is great danger of secondary hemorrhage following the slough consequent upon its use. Puncture of these organs is usually to be preferred.

Caustics and styptics are never to be used.

Punctured wounds with partial wounding of blood vessels and consequent serious bleeding is to be remedied by enlarging the wound if necessary, double clamping the vessel upon either side of the injury, and tying either end.

**Transfusion methods** comprise direct and indirect transfusion, autotransfusion, infusion and hypodermoclysis; of which only the last three are of use, and the last is chiefly to be recommended because of its availability, asepsis, quickness of action,—and its uniformly good results.

Formerly, direct transfusion was done from the median cephalic vein of one patient to that of the anemic or collapsed patient; care being used to prevent sepsis, coagulation of the transfused blood and air embolism, through exclusion of air from the transfusing tube.

Formerly, also, indirect transfusion of defibrinated human, goat's and sheep's blood, and infusion of normal salt solution (.7 percent) was done by means of a suitable reservoir and tubing; care being taken to conduct the

operation aseptically and to have the solution at bodily temperature.

Autotransfusion is artificial ischemia and is of the greatest service.

By far the best of all methods, and considering its neatness, brevity and immediate results, is hypodermoclysis. By means of an eight-ounce syringe and a relatively small needle, normal salt solution is rather rapidly injected into the subcutaneous lymph spaces of the breast, back, axilla, groin and thigh. If the lymphatic structures are not destroyed, the fluid is rapidly taken up by the lymph channels and emptied into the veins.

## THE OPERATION. ITS TECHNIQUE, METHODS, ACCIDENTS. POST-OPERATIVE TREATMENT.

**The operation** begins when all is in readiness. This includes the anesthetization of the patient and placing him with pinned-up arms upon the operation table. The instruments, sponges, solutions and dressings are ready. The lighting is sufficient and secure. There are hypodermics in readiness for shock or other accident. Perhaps a last examination of the heart and lungs is made by the surgeon. The friends are excluded from the room. The operation field is cleared of its soap poultice and again scrubbed, cleared with alcohol and ether, and again scrubbed with bichloride. Moist sterilized towels, or moist sublimate towels are laid over the sheeting and body of the patient, blocking off the operation field. The operator at a nod from the anesthetizer, after again rinsing his hands in the

basin of sublimate solution, picks up an instrument and begins. An assistant, opposite, takes the sponge, wrung out of sterile water and handed him by the nurse, and follows the surgeon's instrument, alternately pressing the oozing or spurting wound and damping ahead of the instrument to clear the view of the field. As a spurter is cut across he clamps the artery and turns it back out of the way. This process is continued till there is a rest or a completion of the operation, when the clamps are removed or twisted free or the larger arteries tied. The wound is then flushed out with hot (120°) water, sponged dry, deep sutures of gut or silk carried throughout the length of the wound at a half inch distance, and tied. The anesthetic is stopped. The skin surface is covered with an abundant sterile gauze dressing, retention straps are applied, the patient cleaned, dried and removed to the sick room.

**Technique.** The surgeon and assistants are supplied with half-sleeved belted-in cotton gowns, and rubber protective aprons as needed, that have been previously steam-sterilized and dried. A few surgeons wear cotton caps and thin rubber gloves, but this is not the general usage.

The first incision of the skin is complete and just long enough. The succeeding tissue layers are incised to its length so as to leave no pocketings. A too-long incision may be closed by a suture or two; but hernia or scar tissue is apt to result, on repair. A too-short incision is remedied at once by enlargement.

An operation wound is treated dry by sponging; or is packed to prevent excessive capillary hemorrhage; or is flushed by pitchers of hot sterile water, normal salt solution, or sublimate, as may suit the case. Clean cases are best

dried, pus cases flushed. In much oozing, insert drainage as a last resort.

Perspiration of the face and forehead during the operation should be carefully removed by a dry towel in the hands of the nurse. The surgeon should from time to time rinse his hands ; the instruments are to be rinsed in sterile water, as they are returned from the operation field, and placed in their tray ; the solutions, sponges and towels about the site of operation, are to be renewed occasionally in order to prevent as far as possible any contamination. Any dropped article, instrument, suture or dressing, is to be excluded or re-sterilized. Any change of operation-room furniture is to be done by an assistant outside the operation, by a foot or elbow, or not at all without re-scrubbing carefully. The instruments, basins and all furniture, so far as possible, are to be glazed and capable of withstanding water and heat, and incapable of lodging germs. They are preferably of iron, glass, hard rubber when necessary, or enameled, gilded or nickled.

**Methods.** The tissues are divided by cutting, tearing, sawing, scraping and the like. They vary as to the kind of operation, the kind of instrument selected for use, and the particular method in use by the surgeon. Roughly, all skin incisions are made with the knife, or scalpel ; farther separation of the tissues is made with the knife, scissors, knife back, knife handle, blunt probe or finger. Dissection of tissues is seldom done with the blade-belly of the scalpel. The scissors and tearing serve to prevent hemorrhage, through trauma of the vessels, In sawing, the soft parts are to be protected by the use of retractors of metal or cotton. Metal retractors of various sorts aid in separating wound edges or in keeping certain tissues in position for

operation. The province of instruments is to simplify and ensure detail. On the other hand, all trauma by them must be avoided, so far as consistent with their use.

The **accidents** of operation are shock, collapse, hemorrhage, syncope, and rarely air embolism and hemophilia. They are to be presaged and prevented so far as possible. They may demand immediate termination of the operation ; and are to be handled as irregular, yet anticipated, concomitants of operation. They are largely remedied by quickness and decisive surgery. An alcoholic or hysterical patient will often develop cramps, cessation of breathing, and frequently interrupt the operation unless the anesthetic is pushed or morphine is given.

**After-treatment.** After removal to his bed, the patient is placed between light blankets and warmed by a hot water bottle or two. These should be covered to prevent burning the still unconscious patient. No pillows are used, and a pus basin and towel are to be placed conveniently in case of vomiting. The room is slightly darkened and perfect rest insured. No visitors nor flowers are allowed for a day or two. The patient is often very restless, and the nurse should change his position frequently and at the same time protect the operation part and dressings from damage. A mustard paper at the epigastrium often prevents continued nausea. If it persists, a hypodermic of morphine and strychine or atropine is given ; but no food nor drink for a half day to two days, if the nausea is protracted. For severe hemorrhage, raise the bed a foot and block it. For collapse, give a hot enema with brandy.

For the pain, change the dressings, or loosen them if there be amputation ; or give a small hypodermic of morphine or a large dose of acetanelid ; or, in abdominal operations with some danger of peritonitis, give dram doses of combined salts hourly ; or, in hysterical and alcoholic patients give nothing and remove all fluids, even to hot water bags. Give a laxative, with or without an enema, on the second day following the operation, and begin fluid diet after a half day to three days. Directly after operation, warn the nurse to watch for hemorrhage and other accident ; and make sure that there is no suppression of urine from paralysis of the sphincter, in which case catheterize as often as every six hours.

Be on guard for contingencies, and be optimistic, and sure of the asepsis.

## AMPUTATION. RESECTION. INDICATIONS. TECHNIQUE. AFTER-TREATMENT.

An **amputation** is the removal of a part or the whole of an extremity by operation. A major amputation constitutes an amputation above the ankle or wrist ; minor, one below ankle and wrist. An amputation is partial, when but a lateral portion of an extremity is removed ; and is primary, when done after the period of shock and before suppuration or inflammation take place.

The **indications** for amputations are accident, suppuration, paralysis and expediency. When tissues are badly lacerated and destroyed by *accident* and there is shock and hemorrhage, the ragged, torn and broken tissues are hurriedly cut away, ligatures or clamps are applied to the bleeding vessels and a hurried dressing applied. The shock

is recovered from in a day or so, when amputation is done. In *suppuration*, septic infiltration of tissues, cancer, tuberculosis and gangrene, amputation is done well in advance of the inflammation, to save the life of the patient. In *paralysis*, retarding and preventing seriously a patient's life work, amputation is justifiable. In certain malformations and atrophies, it is simply a matter of *expediency* and is done largely for cosmetic effect.

In clean cases, as much tissue is saved as possible ; in suppuration and osteosarcoma, the amputation is made high up in sound healthy tissue.

The **steps** of the operation, after making the limb bloodless by Esmarch's method, is first to cut the skin flaps long, whether antero-posterior, lateral flap or circular. This is cleared and retracted, and the muscular tissues cut slightly shorter. The blood vessels are found and ligated. The nerves are pulled down and cut high, to prevent catching in the cicatrix. The soft parts are now well retracted and the bone sawn high up. The stump is well flushed with hot water, till oozing ceases, and dried. The parts are sutured, and drawn together by one or two tension sutures, if needed. A large dressing is applied and firm compression made by bandaging.

Or in suppuration cases, the amputation is done hastily, the arteries are tied, and the wound is packed with gauze by the open-flap method.

The **accidents** are principally shock and secondary hemorrhage. The latter is prevented by care in ligating all bleeding points, obliterating all dead spaces, flushing, compressing, and finally placing the stump in a vertical position.

The **after-treatment** consists largely in sedative and stimulating diet and drugs. Opium or acetanelid is given as required. In clean cases, the limb or stump is dressed

after a week or ten days, the patient being kept in bed with the stump elevated for that length of time. After that he is allowed to get about on crutches.

In septic cases, the dressings are usually large, wet and antiseptic; are removed and renewed daily, or oftener if required. As soon as granulations are profuse, the wound is often scraped and closed by secondary operation, with good results.

Artificial limbs are of great benefit after the stumps become accustomed to their use.

A **resection** is used here in the sense of an excision of a joint, an arthrectomy. It may be partial, as in case of partial injury of a joint that requires an excision in part. Or it is complete, following joint disease, when an eradication of all joint parts is demanded. It is primary, if done immediately after injury; intermediary, if done after recovery from shock, and before inflammation has been established; or, in the great majority of cases, it is secondary, and is done for tuberculosis, osteosarcoma and suppurative arthritis. The joints are usually the knee, elbow, ankle and hip.

**Indications** for resection are progressive disease either of epiphysis or joint; when an injury becomes suppurative, or a diseased condition becomes a menace to life; when there is general suppuration in and about the joint; when there is deformity that proves a hindrance to locomotion and life work. In all these cases, the operation is indicated if only the patient is conditioned to withstand an operation. The danger of the operation is slight. There is uniformly bony union of the bone ends; or exceptionally, there is formation of a false joint, or fibrous ankylosis, that is very serviceable by aid of orthopedic apparatus.

The steps of the operation are first the ordinary but thorough aseptic preparation of the part, and ischemia of the limbs, and ligature. Following that, a large flap incision or H incision is made through skin and soft parts, down to periosteum and joint capsule, on the side of the joint away from the trunk vessels and nerves. This incision covers the breadth of the limb. The articular arteries are clamped and ligated. The soft parts are retracted, the periosteum is incised and pushed back, and the bone heads are sawn at right angles to the bone shafts. If there are signs of softening or inflammation in the bone ends or sawn surfaces, such spots are thoroughly curetted away. The capsule is then exsected, with its connecting bursa or sinuses, and the parts brought into apposition. This is in part to adjudge the allignment of the limb and to take off the drilling points. The operation field is now flushed out with hot sterile water, the bone ends are drilled, and silver or silvered steel nails are driven through the adjacent bones; or in small joints, the bones are drilled and pegged, or wired. The flaps of the soft parts are now sutured, leaving only posterior punctures, stitched open, for drainage. A large gauze dressing is applied and bandaged, and the whole limb put in a plaster of paris cast. Such a dressing should remain in place for six weeks, when complete bony union should be had.

Or, an erasion, or removal of all joint parts save bone and articular cartilage, is done for simple suppurative synovitis. This is done with the expectation of getting simple fibrous union after five week's splinting, and is often successful.

Or, a resection is done, at a lower level, sawing the bone ends. They are now rounded, the elevated periosteum is brought well around them; and a working joint is expected by means of fibrous ankylosis after five to six weeks.

**Accidents** are few. There is the usual shock, and hemorrhage especially from the cancellous bone even when heat has been pretty thoroughly persisted in. More especially is this true after the use of the Esmarch bandage and ligature. This often results in so profuse after-oozing that many surgeons have entirely dispensed with their use in this operation

**Prognosis** is very good if the diseased joint is thoroughly cleared up, and firmly nailed and splinted. Even in tubercular joint there is usually firm bony ankylosis and good repair, though there is concurrent disease in another joint or in the lungs. If the bone ends are not well curetted at the time of the resection, it is often necessary to do it at a later date by re-opening the wound; or sinuses result, and they have to be cleared up as well. Often resection is delayed until a general osteomyelitis of the contiguous bone is under way. Resection then will occasionally result in repair, but the accompanying disease of the bones goes on. Or, rarely, there is general purulent or tubercular dissemination, following and resulting from the operation, and death. Or, both the tubercular joint and the tubercular osteomyelitis are cleared up, and the patient dies late in life of pulmonary tuberculosis.

## PLASTIC SURGERY. FLAP METHOD. THIERSCH SKIN GRAFTING. AUTOPLASTY.

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**Plastic surgery** is the operative replacement of lost parts by reposition, traction, flap-transfer, or by transplantation. Plastic operation upon skin is the one usually

considered as plastic surgery. It comprises in main the flap-method and skin grafting. Plastic operation on tendon and nerve has already been considered under tenorrhaphy and neurorrhaphy. Osteoplasty and myoplasty are also divisions of the plastic art.

The defects are fresh, following injury or operation; or are old, the result of secondary healing or of congenital malformations. Examples of these defects, in the first case, are scalping and flap tears, the result of belt and gearing injuries; in the second, deficiency in skin surface, as in breast operations and contractures. Secondary healing results in large granulating surfaces that skin over slowly, as in burns, frost bite, carbuncle and amputation by the open-flap method. Congenital malformations, such as cleft palate and hair lip, demand plastic remedy.

The main principles of plastic surgery are embodied in coaptation, asepsis from start to finish, and maintenance of nutrition through normal blood supply or lymph film.

**Reposition** of parts recently cut off, such as finger ends, nose ends and ears, is feasible if it is possible to carry out asepsis and coaptation, and to keep the parts quiet. The nutrition is maintained by means of the exudate, until after three to four days the new blood vessels carry on active circulation for the severed members. This is frequently successful in children and often so in adults The line of suture is covered with protective, the part dressed, bandaged, and if possible splinted. Repair begins to show in six to seven days if at all. At that time, if there is no repair in a finger, a secondary amputation may be done. This principle applies to other parts of the body as well.

**Traction methods** may be used especially in the large skin defects following tumor and cancer operations. These are usually placed in the neighborhood of areolar tissue, in which case the skin and its fascia and fat is readily freed

from the underlying tissues. Tension sutures of heavy gut are carried well back from the original incision and anchored by plate or gauze roll guards. By means of these sutures the skin edges are approximately or quite brought together. Interrupted sutures are made and the parts allowed to repair as best it will. Caution however should be taken not to put too much strain upon the tension sutures and so cause pressure gangrene of the skin at the anchorage points. A small defect in skin is rather to be preferred, as it is easily repaired by skin grafts. This is the usual process in hair lip and cleft palate.

The **flap method** is now seldom made use of. Skin grafting causes less inconvenience as a rule and less scarring. It is still employed for minor defects in special cases. The flap may be of any size, shape or device, so long as its pedicle contains its afferent blood supply. The flap is turned in upon the defective area and sutured ; the surface from which the flap was taken is closed by traction sutures. The parts are then dressed and bandaged.

**Transplantation** was formerly practiced by picking up and snipping off small bits of skin from various skin surfaces and bedding them at various points upon a granulating surface. They formed islands of skin outgrowth if they became imbedded and nourished, by means of which the surface became finally skin covered. These bits of snipped-off skin usually failed of nourishment and died.

**Thiersch skin grafting** is applied as a rule only to the skinning over of large granulating surfaces. These surfaces are carefully prepared by thorough washing with saturated boric acid solutions followed by an equally thorough curetting of the granulations, down to their firm bases of fibrous tissue. They bleed profusely, and this hemorrhage must be totally stopped by hot compresses of normal saline solution. Any pockets in the granulating surface must be eradicated

and if possible leveled. The skin edges must be freshened. The surface is now ready for grafts and is kept protected by saline compresses.

The skin grafts are usually taken from the arm or thigh of the patient or of another. This skin surface is prepared as for operation ; shaved, scrubbed, rinsed, cleared and scrubbed with sublimate, and finally with saline. A special flat-backed broad razor is used for cutting the grafts. The skin surfaces are drawn and pressed flat ; and the razor, carried with a sawing motion, cuts the thin grafts, down into the papillary layer and stroma, as wide and as long as is possible without their being pushed off the razor-blade. Each graft, as cut, is moistened and applied to the prepared granulation surface. The skin surface bleeds freely, and this is cleared by more hot saline compresses. This process is continued until the whole granulation surface is covered.

The end of the graft is caught by a probe or anatomical forceps, after being moistened upon the razor, and applied to the surface by withdrawal of the razor from the caught point, thereby allowing the graft to fall, by a reverse of its making, flat upon the granulation surface. The graft is approximated along the freshened skin edges, but not allowed to overlap. Care is taken to clear any fluid from their under surfaces by damping with a dry-wrung compress. Any considerable collection of fluid or blood under the graft prevents its nourishment by the plasma film of the granulation base. This grafted surface is then covered by gold foil, silver foil, or protective or rubber tissue, in strips ; and dressed with dry saline compresses and bandaged. The same dressing is also applied to the skin surfaces from which the grafts were taken.

The horny layer of the epidermis gradually sloughs away leaving the pinkish malpighian layer, or true grafts, after three or four days. At this time new blood vessels

are formed and nourish the grafts. Repair on either or both surfaces takes place in from eight to fifteen days. A negro, grafted with white skin, pigments after several months ; the pigment being carried by the wander cells to the deep layer of the rete malpigii.

Similarly, experiments have been made with skin of frogs, moles and birds, with more or less successful results. Mucous membrane transplants readily. Turned-in skin in repair of the buccal cavity and urethra soon assumes the office of mucous membrane.

In certain cases, borrowed skin grafts seem not to "take" at all, and recourse must be had to **autoplasty** or the making of grafts from the body of the patient upon whom they are grafted. There is no special explanation of this phenomenon.

## ROENTGEN RAYS.

(*After Professor J. S. Shearer.*)

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A remarkable discovery made by Professor Röntgen about seven years ago while experimenting with a Crookes' tube has become of great importance in surgery. Crookes had studied electric discharges in highly exhausted glass tubes and observed the beautiful fluorescent effects produced on their walls. Röntgen found that the ability to excite fluorescence was not confined to the walls of the tube but that a new kind of radiation was developed, capable of penetrating many substances opaque to ordinary light. By courtesy to the discoverer this is commonly known as the **roentgen rays**, or X-rays.

In practice, a glass bulb, of suitable size and shape, has sealed in the opposite ends of its walls two metal terminals.

One of these, the cathode, is of aluminum and is concave ; the other, the anode, made of a metal of great density and high melting point such as platinum or iridium, is plane and set at an angle of about 50° to the anode. The tube is exhausted until a disruptive electric discharge from the cathode to the anode causes the proper fluorescence upon the walls. It seems probable that very minute charged bodies are projected from the cathode and, impinging upon the anode or upon the walls of the tube, excite this peculiar radiation. The concave cathode evidently concentrates this shower of minute bodies upon the anode, securing as nearly as possible a point source of radiation. The advantage of this is seen in the fact that this radiation is impossible of refraction. Objects are seen only in the path of these X-rays by means of shadows cast on a prepared screen, and these shadows increase in sharpness as the light source is made ray-form and small.

The transparency of bodies to this radiation depends inversely upon their density. Metals cast dense black shadows or silhouettes. Bones are a little less dense ; plaster of paris casts are darker than bone ; certain chemicals as iodoform and iodoform gauze are less dark, yet denser than muscle. Lead glass is opaque, while wooden splints, cotton dressings and bandages cast scarcely any shadows at all. Certain dye stuffs cast more or less shadow, while crown glass casts little.

The uses of the X-rays in surgery is scarcely yet to be estimated. Foreign bodies, in the tissues and organs, especially if they are of metal, are readily seen and located by cross-radiography. Foreign bodies developing in the organs, such as gall stones and uric acid calculi, throw but slight shadows ; while nearly all other concretions are rather sharply differentiable under a trained eye and with the use of a low vacuum tube. Pathological disease of bone and

bone tumors are pretty sharply shown. Fractures into joints, doubtful fractures and questionable reduction, as well as the repair conditions of old fractures, are determinable often without the removal of the splints. Similarly, the X-rays give information as to the repair and calcification of resection and amputation, as well as of recent fracture and the reabsorption of its callus. It gives the detail and relation of the parts in deformity. It may at times differentiate joint neurosis.

Recently, inoperable tumors and especially sarcoma have been exposed to the X-rays for ten minute intervals daily; or three or four sittings are made per week. In many cases the rapid progress of a sarcoma is staid. In others the tumor shrinks and ceases metastasis. In still others, there are evident cures. Not enough time however, two years, has elapsed to give these results the stability of success that is undoubtedly warranted.

The **apparatus** of a good X-ray outfit consists of a suitable direct current, a current interrupter, a large induction coil with a suitable condenser, various high and low vacuum tubes, and a screen. For photographing, any convenient apparatus that shall hold steady the plate and the part to be radiographed is all that is necessary.

The *current* must be a constant one and may be generated by dynamo or rotary convertor; or be gotten from an efficient storage battery.

The *current interrupter* causes a relatively large intermittent current of low potential in the primary to be transformed into a very small current of high potential in the secondary. The vibrator should be capable of adjustment for different frequencies.

The *induction coil* should be capable of giving a 10 to 15 inch spark. The thicker and heavier the spark given, the better is its efficiency.

Instead of these, a first class **static machine** of large capacity may be used and by many is considered preferable for fluoroscopic examination, while the induction coil is usually preferred for photographic work.

The *tubes* are of high or low vacuum. The high vacuum tubes give great penetration of tissues ; the low vacuum, or soft, tubes yield the best definition. In using a soft tube care should be taken not to overheat it, so that a purple light appears in it about the kathode. The state of vacuum of a tube varies with its age and temperature. A rise in temperature in a tube impairs the vacuum, which is in part recovered when the tube again cools.

In order to give the operator control over the vacuum, various self-regulating tubes have been devised. There is usually in these an auxilliary bulb, through which an occasional spark may be passed in order to drive particles of matter into the main bulb and thereby lower its vacuum.

When working well in a darkened room, the tube should be full of a peculiar greenish fluorescent light and transfuse the same light upon any fluorescent object placed in the direction of its rays.

The *screens* are various combinations of potassium and barium platinocyanide or calcium tungstate incorporated upon card board or similar material. In use it is set 10 to 18 inches from the tube ; and a part placed upon it for examination casts shadows or is silhouetted upon its luminous or fluoroscopic field.

For **radiographs**, or X-ray photographs, the photographic plate is enclosed in a thin box or in orange paper, and is secured in the place of the screen 10 to 18 inches from the tube and parallel to the anode. During this time the tube must not be in operation, just as during the previous adjustment of the tube and the screen the plate must

be at least 20 feet away from the apparatus to prevent fogging.

The part to be photographed is bound securely to the plate in the desired position. Exposure lasts 1 to 15 minutes depending upon the current and the kind of tube and the dry plate used. The resulting negative gives a clearer radiograph than does its positive print; although recently, by regulating the details and choosing certain kinds of papers, the photographic print is about equal to the plate.

**X-ray burns** seldon take place in single exposures of a part of not over 10 to 15 minutes' duration. They are much more apt to occur as a result of the accumulated effects of repeated exposures, such as is met with in those constantly operating X-ray apparatus during long periods. Otherwise these burns happen once in about a thousand cases in people especially sensitive to the rays.

## SURGICAL DIAGNOSIS.

**Surgical diagnosis** consists in the determination of a wound or injury, or a surgical disease, by all the modern means available; and comprises a consideration of its cause, lesion, course and symptoms, complications, and to a certain extent of the effect of the treatment.

A surgical disease differs from a medical one in that there is need for operative interference. Such a diagnosis may be *conservative* looking toward the preservation of the affected part and the relief of the patient's anxiety; or *interventional*, and recommendatory of surgical interference for the betterment of the condition. A diagnosis may be *differential*, in that it consists of a distinguishing of one

disease from another of allied symptoms by certain characteristics. A *direct* diagnosis is made independently from one or two characteristic symptoms or conditions. Often a disease or injury may be diagnosed only by a process of *exclusion*, by which means one condition after another is excluded through not possessing the particular symptoms of the disease or injury at hand.

**Causes.** The causes may be local or general, and genuine. Or the causes given may be seemingly and totally abstruse, or faulty or misleading. They may be founded upon superstition or ignorance, upon hearsay and even upon suggestion, rather than upon practical physiological and pathological reasoning. A few definite facts elicited and elaborated from correct replies is far better than a long history of origins.

**Lesion.** The diagnosis must be founded upon lesions. This may be determined in the first instance by means of palpation, inspection, auscultation and percussion, in order to decide the character, location and extent of the pathological process. This may be supplemented later by the chemical, bacteriological and pathological examination of the tissues or the tissue products, when obtainable. Or determination may be made in part by means of instruments of precision such as the tape measure, thermometer and hypodermic. When a patient feels himself obliged to come to a surgeon for help, he is usually prepared to undergo a full and thorough examination as a matter of course. If not, he is oftenest a pretender, a malingerer, or one seeking gratuitious advice "for a friend." In the examination of a lesion it is often necessary to use both sight and touch, plus ether,—to operate in order to establish fully the findings.

**Course and symptoms.** In arriving at a diagnosis not only the present course and symptoms are to be determined, but there must be insisted upon a definite statement

of the patient's heredity. This comprises his family history and his past history ; it includes a consideration of his personal character, his grit, his friends and associations, his general education, his family, his previous debility or disease, his diet, mode of living, hygiene, occupation and station in life, his resistance to pain and distress, and the effects of drug-action. These will vary somewhat in expression, depending upon the age of the patient and the mode of eliciting the information. The questions must follow the sequence of cause and effect. Anatomical changes must be kept in mind ; the changes of puberty and the menopause ; the physiology of youth and senility.

The course varies in length of time, it is acute, subacute or chronic ; and the symptoms will vary accordingly. Of the symptoms, pain and the expression of that pain are the most important. Of pain, there must be determined its mode of onset, duration, character, location, its course and persistance, and its results. These results constitute the expression of the pain at normal, or on pressure, or during mobility ; and its influence upon the facies or circulation, digestion, nutrition, or the general nervous system.

Again the size and shape of a part, as compared to its symetrical counterpart, is of great value.

Examine faithfully and fully the mental and physical ability of the patient and the mobility of the affected part. Beware the reaction of a perfunctory examination upon the patient, as much as an abrupt or a brutal one. Moreover, above all things, be observant and use tact.

**Complications.** The complications and their mode of development often make for or against a definite diagnosis. Accident may change the estimate. The involvement of neighboring tissues, and their varying condition and their functional disturbance, may entirely change the values of a diagnosis.

**Prognosis.** The lesions of the old are always serious ; while chronic disease has usually a favorable outcome. Statistics are useful in prognosticating the condition. Experience tells the surgeon when to recommend exercise, when to keep the patient quiet ; and thus indirectly favors an early diagnosis and a favorable outcome. Depending upon the patient's mentality, the surgeon is often aided or hindered in diagnosis ; and not infrequently is a man's own innate judgment the best prognosis.

**Treatment.** By applying to a diseased condition the facts of the previous course and the treatment if any, much assistance may be had in determining a diagnosis. Or delay diagnosis, and prognosis as well, and watch further progress of the condition under care and quiet and treatment. This is quite as justifiable as non-interference in desperate or inoperable cases, and the continuence of a purely tentative or palliative treatment.

Finally, have method in the general examination of the patient. Start from the principal painful or non-functional point and carry out the questioning along lines of associated symptomatology, and so form differential diagnosis. Begin anatomically with the various symptoms referable to the head, then to the organs of the chest and the abdomen, the upper and the lower extremity ; and so accumulate facts toward formulating a definite diagnosis. Get expressions from the patient of his general ability or debility. Study both the patient and his answers, occasionally guiding and correcting his ideas ; and checking it all by experience. Often it is necessary personally to examine, for information and inspection, a patient's friends or his home surroundings, diet and habits in order to establish a diagnosis. At other times, it is necessary to protect a patient from his friends by his removal, in order to favor

either diagnosis or recovery. All these things, and more, have their bearing, and hinder or favor diagnosis.

Form a mental picture of the surgical conditions. Withal, this picture shall conform to certain set patterns of disease types, generally with many overlaps and often with equally as many deficiencies. This comparison of picture and pattern shall make the diagnosis a certain one, with exceptions. Or these exceptions, with a varying progress of the surgical conditions, may confirm a different and new diagnosis, and signify a changed condition. In formulating such a surgical picture, reason from the chief or main cause and effect, or symptom, to equally definite symptoms or causes. Keep the sequence of cause and effect forever in mind. Build upon the chiefest until the picture is complete. Does the patient look sick; what conditions are possible; what are the probabilities; are the causes and the symptoms sufficient to explain the condition; what may be the anticipated mortality and the patient's chances; what have been his previous excesses; what privileges has he taken in his statements;—all these affect the diagnosis.

Work for good results always. Make the diagnosis what it is, even at the expense of the patient's wishes or preclusions or his presumptions. And in expressing the diagnosis to him or to his family, and through it the prognosis of his condition, the surgeon shall be candid and direct, and yet kind.

## SOLUTIONS.

The solutions made use of in surgery and in surgical preparations are either aseptic or antiseptic. The aseptic preparations may be said to be sterile water and normal saline. The antiseptic solutions are sublimate, phenol and its congeners creolin and lysol, boric, Thiersch, aluminum acetate, formaldehyde, peroxide and acetozone.

**Sublimate,** or bichloride of mercury, is used as an antiseptic in the preparation of the patient, or of the hands, or is employed in the actual operation field, in solutions of the strength of 1-1,000 or 1-2,000; or upon mucous membrane, 1-10,000; or as an irrigant of nasal urethral or vaginal mucous membranes and the various serous cavities, 1-20,000.

As a simple solution of the sublimate combines with blood serum to form the so-called albumenate of mercury its use is said to be objectionable; since microscopically there is demonstrable that it forms upon the surface of fresh tissues an almost imperceptible film, that at the immediate time has the effect of shutting bacteria present in the operation field into the tissues and at a remoter period undergoes necrosis and sloughs off. To avoid this result and to preserve the sublimate in solution, so to speak, the sublimate is combined with citric or tartaric acid. But this renders the solution more easily absorbable and poisonous, especially from pockets and moist dressings. Therefore many surgeons prefer to aid its coagulability and at the same time its solubility by adding approximately equal parts of sodium chloride and ammonium chloride.

In practice, tablets are made, say, of 7.7 grains of the mercuric chloride and 7.3 grains of the ammonium chloride, colored with an aniline blue as desired, that go rapidly into

solution when dropped into water. One tablet to a pint of warm water makes a sublimate solution 1-1,000. This tablet also has another good feature; it prevents the combination of the sublimate with the earthy phosphates common to all plain water, and the precipitation of the sublimate. Otherwise there is the necessity of using boiled and sedimented water or distilled water in order to avoid the precipitation and to obtain standardization of solutions.

*Sublimate poisoning* causes upon the skin, itching, burning, and the formation of papules and vesicles. This is largely due to sublimate dressings. It soon clears upon removal of the dressings.

General systemic poisoning gives salivation, dizziness, nausea, vomiting and diarrhea, if acute; and if chronic, dizziness, restlessness, prostration, salivation and bleeding of the gums, fetid breath, vomiting, profuse diarrhea with or without bleeding pain and tenesmus, and acute congestion or degeneration of the kidney.

Treatment is discontinuance of the mercurial, salines, albumens such as milk, and stimulants. A mouth wash of permanganate, or of potassium chlorate, is of service.

**Phenol**, or carbolic acid, is of use especially in the treatment of the infectious surgical diseases, as a .5 to 1 percent solution; or as a solution for the instruments, 5 percent, afterward at the time of operation reduced to 2 percent in order not to destroy the skin of the operator nor render it anesthetic. Care must be taken in the use of phenol solutions, and especially in the form of moist gauze, in that it often dries and causes the solution to increase in percentage strength, and produces severe phenol burns and gangrene. Taken early, 20 percent alcohol seems to be a perfect antidote.

*General constitutional poisoning* is usually acute; and in the mild cases causes malaise, headache, dizziness and tinni-

tus, vomiting, the small pulse of prostration, and a characteristic olive green urine.

The severe cases go on to unconsciousness and complete muscular irritability. The pupils do not react to light nor distance, and are often contracted. There usually is suppression of urine and hematurea, or albumenurea. There is sometimes intestinal hemorrhage.

Treatment is discontinuance, emulcients and the sulphates, relaxants, and alcoholic stimulants.

**Creolin** is a coal tar derivative, after the separation of the phenol. It is used in 1 to 2 percent solution in water, is milky, and is a much more effective antiseptic than phenol. It is very efficient in septic cases, and promotes granulations. It has a strong pungent odor, and cracks the hands if used to any extent.

**Lysol** is a cresol derivative, saponified. It is used in about the same way and with the same efficiency as creolin.

**Boric acid** is a non-irritating antiseptic of considerable efficiency. The skin especially repairs well under its use. It is used in 1 to 3 percent solutions and is non-poisonous. In the form of **Thiersch**, it comprised 1 percent boric and .2 percent of salicylic acid, and was formerly much used, especially in plastic surgery. Both are substitutes for sublimate.

**Aluminum acetate** may be made of 1 percent alum and 5 percent acetate of lead in watery solution. It is a splendid substitute for phenol in septic cases; but has the great objection of cracking the hands if used continuously. Otherwise it is very agreeable to use, filtered or unfiltered. It should be prepared a day or so before use.

**Formaldehyde** is used in .5 to 1 percent solution, but as it is a comparatively poor antiseptic and is irritating both to skin and mucous membrane its use is almost debarred.

**Peroxide** of hydrogen has been used for years in large quantities as a feeble antiseptic without much effect; until to-day it must be classed among such household remedies as witch hazel, arnica and carbolized vaseline. Its only practical office is the detection of pus, through effervescence.

**Acetozone,** or benzoyl-acetyl-peroxide, is a new and non-poisonous germicide that in freshly prepared solutions 1-800 to 1-30,000 has proven very effective in intestinal lesions such as typhoid.

**Sterile water,** or distilled water, is much used in the operation field where its use is but slightly irritating. This irritation is probably due to the dilution of the serum and the plasma of the tissues. It is also of use in making up all solutions.

**Saline,** or normal salt solution, is presumably in all cases the best irrigation fluid in use. It is made up in .6 to .7 percent, corresponding in strength to the physiological salinity of the bodily tissues, and in the operation field is without irritation to the tissues or interference with the serum alexins. Repair is immediate after its use. In the art of surgery, in combination with dry sterile gauze sponges, it has no equal.

The continuous use of solutions irritating to the hands of the operator is a grievous one. The only solution that will not finally cause the skin of the hands to bronze, crack, become sensitive and bleed, is the saline. This, in combination with the thorough use of brush and soap and the bleaching mixture, is capable of continuous use, makes the hands soft, tactile and aseptic, and leaves them soft and uninjured in every way.

## POWDERS. PROTECTIVE.

The principal antiseptic powders are iodoform, aristol, bismuth and zinc. The protectives are Lister's, rubber, Z. O. plaster, collodion, and the various gold, silver and tin leafs or foils.

**Iodoform** is a good hemostatic and antiseptic. It is not soluble in water nor serum, and it exerts its antiseptic action only through decomposition and liberation of its iodine in the wound excretions. It irritates the wound surfaces and limits its excretions, having a most beneficial action upon granulations. It has a most unpleasant penetrating and clinging odor that may be disguised in part by balsam of peru, or aromatized by coumarin.

*Iodoform poisoning* varies from very mild cases giving symptoms of erythema, headache, malaise, loss of appetite, nausea and vomiting; to those of which high temperature or delirum or coma are the prominent symptoms, and where the patient pretty regularly dies. Treatment alkaline.

**Aristol,** unlike iodoform, has a relatively small proportion of iodine, has only a faint balsamic odor, is non-poisonous, slightly hemostatic and is but sparingly soluble in the wound secretions. It is a very fine powder, causing little or no local irritation in the wound, and is nearly or quite hydroscopic. In the ordinary non-tubercular wound it is usually far preferable to iodoform; but in tuberculosis, it cannot compare in good results as regards lack of pain and hemorrhage and good repair that follows the use of iodoform.

**Bismuth,** either in the form of subcarbonate or subnitrate, is an especially good dressing in burns and acute ulcers. It may be used alone or in combination with boric acid and zinc oxide in chronic ulcers. It is mildly astrin-

gent and antiseptic, and is non-poisonous with the possible exception of arsenic which is a frequent impurity.

As the subgallate, or dermatol, it is antiseptic, mildly astringent and a good hemostatic.

**Zinc** was formerly much used in solution, in the form the escharotic and strongly antiseptic zinc chloride. Its use is now largely abandoned. As a powder, zinc oxide acts as a moderately active substitute for iodoform in cases of poisoning by that drug, and as a mild stimulant in chronic skin lesions.

**Lister's protective** was a waterproof silk taffeta, used in the days of the carbolic spray. Its use is now largely confined to skin grafting, and often dispensed with even there.

**Rubber tissue**, or thin rubber vamping, is of value as a dressing in skin grafting or in the suture line of abdominal wounds. It prevents direct absorption of the wound secretions by the dressings, but is a great aid in the skinning over of small granulating surfaces.

**Z. O. plaster** is of service in the closure of small wounds by strapping, is unirritating, and is capable of being left in place one to two weeks without loosing its adhesiveness or causing inflammation of the skin at the edges of the straps.

**Collodion**, either of the flexible or the contactile variety, is used directly to close small wounds, or indirectly in the way of the cotton or gauze patch. It is a poor substitute for suture, and is easily forced off by even capillary oozing. It is capable of remaining in situ three to five days and is useful in small face or scalp wounds.

The various **leafs** or foils of gold, silver and tin, have been advocated and used for some time. They prevent the adhesion of dressings to the wound closure.

The modern practice of operation wound closure by frequent interrupted suture and the application of sterile dry gauze dressings, without the interposition of either protective or powder, is growing more frequent and general. Protective frequently walls in the secretions; while powders mat in the secretions, and clog the gauze meshes, and in the wound act as an irritant. The purely aseptic treatment, following perfect coaptation of the skin edges, is gaining the best results.

## LIGATURES AND SUTURES.

**Ligature and suture** materials are usually made of catgut or silk. Other special materials are chromicized catgut, silkworm gut, kangaroo tendon and silver wire.

**Catgut** is the outer layer of sheep's intestine, macerated, cleaned and twisted into strings. In a "raw" state as seen in the shops, it is impregnated with fats and some foreign matter. It is prepared for ligature by wiping or soaking in ether and boiling in alcohol. It is then stored in alcohol, or in sublimate alcohol, or in iodoform in solution in alcohol and ether. Or, it is cleared in ether for 24 hours and boiled in alcohol for two hours; when it is stored dry. Or, the catgut is to be purchased upon the market, that has been cleared in xylene and boiled in cuminol at a temperature of 300°; and that is enclosed, a single ligature, dry, in double sealed envelopes, in assorted sizes. For use, any of the alcoholic or dry preparations of catgut are hard and harsh, but are readily rendered immediately flexible by use or by previous emersion in a solution. The special advantage of the single dry ligatures is that they are readily stored; are ready for immediate use by simply tearing open

the envelope ; and there is no danger of contamination of the remaining suture material, as when it is spool wound.

**Silk** is boiled in 1 percent soda solution, thoroughly rinsed in sterile water, and then boiled and preserved in alcohol. It is obtainable either as twist or braid, in all assorted sizes, white or black. The white braided silk is quite as good as any, and may be sterilized by boiling in alcohol and preserved dry in spools or in short skeins. It may be preserved dry by the envelope method ; in which case it is apt to absorb moisture and become contaminated by capillarity. If kept in spools it must be frequently re-sterilized.

**Chromicized catgut** is cleared as before ; then soaked for varying intervals, 6 to 24 hours, in .5 to 1 percent of chromic acid. This is then boiled in alcohol as before, and has the property of being capable of delayed absorption in the tissues, for periods varying from four to sixty days.

**Silkworm gut** is prepared much as silk and is practically non-absorbable.

**Kangaroo tendon,** reindeer and whale tendon are prepared by boiling in soda solution, and then boiling and preserving in alcohol. They have no especial advantage, if any, over catgut , except that they are absorbed slowly, are large, and may readily split to any desired size.

**Silver wire** is boiled in soda, cleaned and boiled ; and preserved in alcohol, or dry ; or is boiled and cleaned each time as needed.

Catgut is used in all fields of operation, in its assorted sizes, and does good service especially where the parts are sure of primary union within the four to eight days that the catgut is being absorbed. The dry single braids or coils of catgut are the most available form. They come in lengths of 20 to 30 inches. Where a suture material is needed, as in suture of the abdominal wall, that shall not absorb under

10 days, heavier catgut is used or the chromicized catgut. Or, the silkworm gut or silver wire may be used and afterward removed. This however gives the possibility of an infected sinus. Silk, by its absorbing power, is apt to give stitch abscess. It is mainly used as ligature for large blood vessels, the uterine tubes, and buried stumps. Silver wire may be used in operation upon the cervix, where it is no better than heavy catgut nor silkworm gut; or in bone wiring, where many times it has not even the advantages of a chromicized catgut, but where the ends may be hammered flat and left in situ.

## DRESSINGS.

The **dressings** of operation wounds are largely those of dry cheese cloth pads; over which pieces of plain sterile absorbent cotton are placed, to effect protection and drainage. The dressings of granulation wounds, cavities and otherwise infected wounds, are similarly prepared; except that wicks of cheese cloth, or rubber drainage tubes, or packing, or tamponade are often brought from the bottom of the wound into the dressings, to effect drainage; and the dressings are often maintained moist, or moist antiseptic. Many surgeons are still using antiseptic gauzes of sublimate, phenol, iodoform, aristol and zinc; but the custom is largely passing. These prepared gauzes, especially the first few, are so readily prepared extempore from sterile gauze that there seems no very good reason for keeping them in stock.

**Cheese cloth** may be bought in bulk in the shops and boiled first in a soda solution to remove the oils, and then in plain water. Or the cloth is steamed half an hour in

superheated steam ; and is fully cleared of oil and infection. The desiderata of a good gauze are that it shall be sufficiently firm and have a relative large mesh. A mesh 12 by 18 is suitable for dressings ; while a mest of 28 by 36 is often desired in a bandage. It is made up in roller bandages, 1, 1½, 2, 2½, 3, 3½, 4 and 6 inches in width, and 5 or 10 yards in length ; or in small compresses of loose gauze caught by a few stitches and used as sponges ; in larger folded pieces, to be used as pads ; or is folded in 4-inch widths, 10 yards long, and cut later as desired, for loose gauze dressing or as pads. After sterilization, the bandages are usually wrapped in oiled paper, sealed and labeled ; the pads and dressings are packed in convenient lots, with or without cotton, and enclosed in a sterile towel, to be opened as needed for use.

In case **antiseptic gauzes** are needed, the sterile roller bandage or dressing is immersed in a solution of the required strength, wrung and used. The prepared, ready-to-use, antiseptic gauzes are now seldom used. The only exception to this is **iodoform gauze.** It is prepared by first washing the iodoform to render it aseptic, mixing it with a suitable amount of glycerine, and incorporating this mixture into a sterile gauze in varying proportions of one to three percent of the iodoform by weight.

**Wicks** are made by enclosing gauze in a thin rubber sheeting and cutting in suitable lengths. The rubber prevents the granulations of a wound from growing into the cheese-cloth mesh, and sticking. It also facilitates the insertion and removal of the wick ; and prevents the secretions from irritating the granulation surfaces, and causing them to be exuberant and to close in the drainage openings too early. Otherwise, wicks are made from roller bandage of suitable widths or of strips cut from a folded dressings.

**Sponges** are best made from loose gauze, caught in a smooth flat parcel two and one-half by four inches, or any other convenient size; sterilized and packed dry in towels containing six to a dozen. At times absorbent cotton is enclosed in gauze; but it is not so satisfactory as the gauze alone, as the cotton is apt to mat. After using, these sponges are thrown away. Sea sponges are no longer used.

**Tampons** are made of cotton or gauze, enclosed as a ball in gauze, and tied. They have no especial advantages over sponges or bandage for packing cavities.

**Bandages** for retention of dressings are uniformly of gauze. Often as in an abdominal dressing, however, bandages of open-meshed muslin are to be preferred; or a many-tailed muslin bandage is used; or, no bandages whatever are used, the dressings and cotton being simply strapped in place by Z. O. plaster straps. Or, as in perineal operation wounds, the dressings are retained by a T-bandage. Or at times the bandaging of extremities, after removal of dressings and casts, is done with flannel or canton flannel bandages, that are more resilient than those of muslin or gauze.

**Cotton** for pads, pressure and extra dressing, is found upon the market already cleared of its oils, and fairly absorbent and sterile. It can be readily re-sterilized; and for operative work this should always be done. It should be of medium length of fibre, neither short nor long, and be perfectly clear of all extraneous matter.

Any or all these preparations or dressings are most conveniently packed in parcels and lots, and folded in towels. These packets may then be re-sterilized from time to time as necessity demands, without unwrapping. Iodoform gauze should be frequently re-sterilized to clear it of infection, as

it is only in solutions with wound excretions that iodoform is antiseptic. Moreover, any arrangement by which surgical dressings may be used in packets and small quantities, without disturbance or danger of contamination of the bulk of such dressings, is best and most satisfactory.

## IMMOBILIZATION.

The **immobilization** and fixation of an operation wound, fracture or dislocation, is made by means of stiffening materials such as splints, starch bandages, plaster of paris, shellaced felt, or water glass. In the case of fracture of bone shafts, and displacement through muscular spasm, use is made of suspension, Buck's extension and various methods of extension and counter extension. In orthopedics, various special devices of jointed and angled apparatus are used.

**Basket splints,** one-twentieth inch in thickness, two and one-half to three inches wide, and of any suitable length, made of birch, elm, beech, or maple, are a most desirable splint. They may be molded by emersion in hot water; made into splints of any angle by notching and cracking the fibers at any point; and may be made of any flexibility or stiffness, according to the number of these splints superimposed upon each other. They are readily cut with bandage scissors, rounded, or shaped and sized as desired. They mold to conform to the extremities and are easily incorporated into plaster of paris dressings. They are very inexpensive, light, sterile, and adaptable to many or all forms of immobilization. As needed they are padded and retained in position by bandages or straps of adhesive plaster.

**Starch bandages,** an ordinary gauze bandage rolled in thick corn starch emulsion, or cotton crinoline wet thoroughly through, are a means of obtaining bandage casts of light weight. The principal objections to their use are their bulk, the length of time necessary for them to dry, and the danger of breaking them during the drying process and afterward. They readily soften through moisture of the wound excretions or perspiration, and lose shape and consistency ; or they crumble and soften on use, as in sprained ankle.

**Water glass,** a thick acidulated solution of potassium and sodium silicate, is incorporated into gauze bandage by re-rolling ; and is applied in fractures, as a bandage splint. It is a very light and firm splint when dry ; but is irritating to the skin both of the user and the patient, wherever it touches ; and it requires 36 to 60 hours to dry out. It is most frequently applied as a final splint in fractures, after union, when the patient still needs support for travelling.

**Shellaced felt,** felt incorporated well with ordinary shellac and the alcohol allowed to evaporate, may be kept in sheets or in splint forms ; and when needed, is softened in hot water, molded and cut to any desired form. It soon dries or hardens again, and constitutes a good stiff splint of fairly well moulded form. It is clumsy of management, soon softens with wound excretions, and often becomes sticky, and is not always ready or economical.

**Plaster of paris** is used as a retention dressing, by means of filling open meshed gauzes or crinoline bandages with it. These bandages are soft-rolled. After becoming saturated with water by simple emersion, the bandage is applied in cast-form over a protective dressing, or is rarely applied directly to the shaven skin. Such a cast is of various thickness, $\frac{1}{8}$ to $\frac{5}{8}$ inch, and is simple ; or is strengthened by cross strapping, splints, wire gauze, telegraph wire or iron rods, depending upon the uses for which

it is intended and the abuses that it is necessary to withstand. Such a cast may be applied directly over wound dressings and afterward fenestrated for the readier dressing of the wound. Or, the cast may be split and removed, punched for lacing ; and afterward replaced and laced, or simply held in place by circles of adhesive plaster or bandaging. Or, the cast may be interrupted, with iron bridging carried in the cast and over joints, to facilitate access to the joint ; or suspension wires are molded into the plaster and act, after hardening of the plaster, as suspension loops and rings. Or, Buck's extension is first applied over two joints, as in fracture of the femur, in order not to cause traumatism of the knee joint and relaxation of its ligamentous structures ; and over the whole, a plaster of paris cast or jacket is applied. Weights may now be applied to the foot piece of the extension dressing, and counter extension exerted by raising the foot of the bed. Or, extension is made by suspension, as in scoliosis ; and a plaster of paris jacket is applied and dried, while suspended. Or, wire gauze is incorporated for strengthening ; or for hinging such a jacket for readier removal.

Plaster of paris is also applied in the simpler method of Stimson's strap dressings, for sprained ankles and Pott's fracture. This gives a rapid and very efficient immobile dressing that is superior in many ways to casts in that it is light, quickly applied, dried, removed or renewed. It is then held in place by a turn of bandage or by adhesive strapping. Plaster casts are removed by the knife or cast saw.

Pasteboard, wire, wire mesh, gutta percha, zinc and raw hide splints have been used in varying forms and models and with various success, but none are as useful as those given above.

Special fixtures are used in certain fractures ; such as

the inclined plane, the railroad track, or Volkmann's sleigh. Or only sand bags are used, as in fractures of the hip in old people ; or the fracture box and sand are used, according to the necessities or the emergencies of the case.

Sayre's adhesive plaster dressing is undoubtedly the best treatment in such conditions as fractured clavicle and in Colles' fracture.

Otherwise the treatment of wounds and fractures is best controlled by use of splints and plaster dressing. Dislocations are often best immobilized by bandaging and adhesive dressings.

**Orthopedics** is a division of special surgery.

## SURGICAL APPLIANCES.

Certain **hospital appliances** make for the comfort of the patient, and asepsis, and the convenience of the surgeon and the nurse. Not infrequently the lack of them causes sepsis or severe complications. The efficient surgeon takes what he has to do with, and extemporizes and does his best. But he needs certain aids. Often the *qua sine non* is some simple contrivance the want of which is essential, and the lack which is vital to the patient.

Such surgical appliances may be briefly listed, as the suspension frame bed, the water bed, cradle, head or back rest, air or water rings, cushions, sand bags, bed pans, urinals, ice water coils, ice bags.

In fracture surgery, especially if multiple, the **suspension frame bed** is of utmost importance. Without it, change of bedding, dressings and the ordinary evacuations are tedious and painful, if not almost impossible. This invalid bed is arranged as a moderately high posted bed with

mattress. Over this is carried a stretcher made up of removable straps. In use, the bed or mattress is lowered by means of a gearing, to any desired amount, while the patient is left supported upon the straps of the stretcher. After a dressing or an evacuation, the bed is again raised into position for the patient to lie his weight upon.

Many chronic invalids and especially seniles become bed ridden, have contractures, emaciation, and especially bad circulation. These are prone to have bed sores, or chronic or plagedenic ulcers. The ordinary hard hair mattress only serves to make their condition worse. With the best of care, these superficial ulcers go from bad to worse. Recourse, now, is had to a **water bed.** This consists of a heavy bag of mackintosh, that is filled by pumping it full of water. Air is sometimes used, but is by no means so satisfactory. On this water bed, due to the law of hydraulics, there is uniform pressure on all points ; and an immediate improvement in the general well-being of the patient.

Certain fractures, wounds and joint inflammations,—in especial rheumatism,—and certain patients, are so sensitive to the slightest pressure, motion or air drafts, as scarcely to be able to withstand the bed clothing. For such the use of the **cradle** is indispensible. This consists of a semi-cylinder, of some light frame work of iron and wood, that shall serve to raise the clothing from the injured and sensitive member and cause a tenting of warm air. It should be broad enough from side to side to allow the patient to turn freely, if possible ; and patent, so as not to interfere with dressings and care of the patient.

**Back** or **head rests** are simple accessories of any sick bed, attached or not ; whereby the patient, when sufficiently improved to warrant it, is brought mechanically to a reclining or semi-sitting posture for meals ; or for a change whereby his horizon is carried beyond the footboard of the bed.

This obviates a laborious change of pillows or the awkward inversion of a small chair, so commonly used for this purpose.

**Rings** made of rubber, in various sizes and shapes, are of the greatest use in resting a patient or a position. They are regularly half inflated with air, or may be filled in part by warm or hot water. A full ring is seldom comfortable.

**Cushions** are most useful. Patients get pressure sores, tender points over bony protuberances, and soreness from wrinkled sheeting ; or they get hamstring lameness, or pressure analgesias, from their extended and constrained positions. These are all relieved by massage and position. Cushions maintain semiflexed positions without exertion on the part of the patient, and are readily changed. They may be hard ; but more often are desired to be soft, yet of some considerable consistency as of curled hair. They should be arranged with removable covers and waterproof ticking, and be otherwise capable of ventilation and sterilization.

The inflated rubber ring **douche apron** is a great convenience for small operations and dressings, where drainage of wound secretions and solutions is needed to prevent soiling of bedding. It is manufactured in various sorts and sizes of the ring pad and its attached apron.

**Sand bags** of various shapes and sizes are most useful for hip rests, for maintaining position of limbs and of the body, and for various other purposes where weight and permanent fixation is desired. They are especially useful in certain fractures where splints are impossible. It is a desideratum that they be not overfull, nor leak sand.

**Bed pans,** and a modification of them in the douche pan, are frequently an absolute necessity. Without the invalid bed, the bed pan is a necessity. No home is complete without a bed pan, a douche pan, a hot water bag and

a fountain syringe. For cleanliness of the bowel is a daily necessity, especially in the sick, in order to prevent intestinal toxemia.

**Urinals** of glass or of porcelain are a great convenience, and without the bed pan a necessity.

**Ice bags** are a convenient method of applying continuous cold to the head, to septic lymph nodes, to the abdomen, or over the stomach or heart. They should be of new rubber, large mouthed, and capable of fastening without leaking. Short of such conveniences, sheets of rubber vamping may be filled ; and caught and tied in bag form. They should be half filled with medium cracked ice, and not prove bulky nor too heavy for the patient.

**Ice water coils** are a simple modification of the ice bags, whereby ice water is continuously passed from a tank through a coil or plat of light rubber tubing placed upon the person ; to overflow into any convenient recepticle upon the floor. It is then returned to the ice water tank, for transmission again through the coil. The rapidity of flow is governed either by the height of the tank or the size of the tubing, intake or overflow ; and the degree of cold, by the icing of the tank and the intervention of cotton or flannel between the coil and the skin surface.